THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 29. Thursday, January 31, 1924. No. 389.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

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Forthcoming Events.

FEBRUARY 2.

Staffordshire Iron and Steel Institute:—Annual dinner at Dudley.

Institute of British Foundrymen (West Riding of Yorkshire):—Ordinary meeting at Wakefield. "Handling of Foundry Materials," Paper by J. Haigh.

Institute of British Foundrymen (Lancashire Branch):—Ordinary meeting at Manchester. "Some Foundry Reminiscences," Paper by R. Buchanan, F.R.S.A.

FEBRUARY 5.

Institute of British Foundrymen (Lancashire Branch, Burnley Section):—Ordinary meeting at Burnley. "The History of the Manufacture of Cast Iron." Paper by T. Makemson.

FEBRUARY 6.

Institute of Physics:—Ordinary meeting in London. "The Physicist in Metallurgy," Paper by Professor C. H. Desch, D.Sc., F.R.S.

FEBRUARY 8.

Institute of British Foundrymen (Sheffield Branch):—Annual dinner.

Institution of Mechanical Engineers:—Extra general meeting in London. "Repair and Upkeep of Pneumatic Tools," Paper by R. W. Wilson.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT, 1923-24, Oliver Stubbs, M.I.Mech.E., Openshaw, Manchester.

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Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Bricking Furnaces.

Every large steelworks possesses its gang of specialised bricklayers, under the control of an experienced foreman, but in ironfoundries the work is usually left to the furnacemen. The requirements are relatively much simpler in the latter, but this constitutes a good reason why they should carefully study the methods obtaining, say, in basic electric furnace practice, which imposes the severest conditions on the refractories used. If the foundrymen followed the precepts laid down by the steel furnace manager, he certainly would not confine his stock of refractories to firebricks and ganister (or a substitute), but would enlarge it to include silicas, magnesites and chrome bricks, and he would make efforts to have these supplied in special shapes to take the curvature of the cupola. The expansion of each brick would be ascertained, so that a ring formed from them would not be under excessive pressure at the temperature where they would be tried. Tolerances for every dimension should be specified, for unevennesses introduce either an excessive amount of cementing material or the unequal loading of parts. We suggest that from the base to just above the slag line silica bricks should be used. From this point up to where the charge is likely to hit the bricks, courses of well-shaped, good-quality firebricks are all that is necessary. From this point to half-way up the charging door we suggest that either chrome bricks or the hard variety of magnesites should be used. Above this point the cheapest variety of firebricks will answer. It is then suggested that the silicas and firebricks should receive a thin coating of some fine refractory paste, only a quantity sufficient to fill the interstices of the brick surfaces being given. The object of this is to reduce the surface area exposed. A refractory surface is always the most efficient when it is just glazed, that is, when it has a minimum surface area exposed. We have suggested silicas for the crucible of the furnace because they have a higher refractory value than ordinary firebricks, and, additionally, they resist slag erosion better. It is, however, unnecessary to use them above the slag line, and, for the sake of economy, we have suggested firebricks. The suggestion that either chrome bricks or a type of magnesite should be used near the charging door is solely on account of their mechanical strength. It takes five to ten times as long to cut such bricks to shape as it does a silica or firebrick.

The above suggestions may be thought a little fantastic by the old-fashioned foundryman. This is because it aims at dealing with three problems. The first is the reduction of time spent on fettling the cupola after each run; the second is to reduce lining renewals, which are sometimes supposed to be heavy with mechanical charging; and the third is the general increase in the life of linings, which, fortunately, does not usually count for very much when calculated to cost per ton of metal melted.

It will take an appreciable time for the manufacturers of refractory bricks to appreciate the importance of supplying bricks and shapes dead true to the dimensions specified, but sustained efforts by all concerned will considerably accelerate this desirable consummation. Generally speaking, the quality of British bricks is high, and if the makers will only concentrate on higher baking temperatures and the delivery of their products "true to size," considerable national economies should be shown.

Proposed I.B.F. Branch in Cardiff.

A very successful meeting was held last Saturday in Cardiff, though obviously it was much interfered with by the railway strike. Mr. Oliver Stubbs, the President, was unable to get through from Manchester, and no visitors were present from Swansea, though some forty foundrymen had sent for tickets. However, about seventy people were present, and much enthusiasm was displayed.

The meeting had been organised by Mr. J. J. McClelland, M.I.Mech.E., who is acting as Honorary Secretary *pro tem.*

In absence of Mr. Stubbs, the chair was taken by Mr. J. Ellis, a past-President of the Institute.

Mr. Ellis reviewed the growth and work of the Institute from its inception.

Mr. McClelland then lectured upon "Warping and Shrinkage in Cast Iron," illustrating his remarks with lantern slides.

An excellent discussion followed, in which Messrs. Herd, Fletcher, Roberts, Hills, Bradley, Roberts and Howe took part. After Mr. McClelland had replied, a resolution was put to the meeting that it was desirable to form a Branch. This was unanimously agreed to, and a number of membership forms were handed in.

A detailed report of the meeting will be given in our next issue.

It is abundantly clear that a second meeting must be held in the near future, when there is no interference from industrial disturbance.

Iron and Steel Institute.

The Annual General Meeting will be held on May 8 and 9 at the Institution of Civil Engineers, the annual dinner being held on the evening of Thursday, May 8 at the Hotel Cecil. The Council is prepared to consider applications for grants from the Carnegie Fund in aid of research work on some subject of practical importance relating to the metallurgy of iron and steel or allied subjects. Application forms can be obtained from the secretary of the Institute.

Death of a Prominent Tyneside Foundryman.

We regret to announce the death of Mr. Robert Wallis, Wh.Sc., M.B.E., the first president of the Newcastle Branch of the Institute of British Foundrymen. Mr. Wallis was connected with the Wallsend Slipway and Engineering Company, Limited, Wallsend-on-Tyne, for many years. He took an active interest in all educational matters, and was chairman of the Surtees Memorial Fund.

Catalogue Received.

Belt Conveyors. We have received from Messrs. Steel Belt Conveyors, Limited, of Norwich Union Chambers, Birmingham, a handsome brochure outlining a system of band conveying, employing a linkless flexible steel band. It would be of greater interest for foundrymen if it included any experience the firm has of conveying damp moulding sand. This is a problem which has not been generally solved so far as this country is concerned. The catalogue is available for all foundrymen who may be interested.

AT THE ANNUAL GENERAL MEETING of the General Refractories Company, Limited, Sheffield, which was held on January 17, the chairman, Mr. Frank Russell, F.G.S., announced that the past year had been one of the most successful in the history of the company, and that recent developments, and particularly the Bramcote Sand Quarries and the Masson Fluor Spar Mines had fully justified themselves. Further developments during the current year, to meet the great demand from the foundry industry, were foreshadowed, and it was noted with satisfaction that the foundries appeared to have entered upon a period of comparative prosperity, as their requirements were quite double what they were a year ago.

Brittleness in Malleable Cast Iron.

According to Technological Paper No. 245 of the American Bureau of Standards, entitled "Embrittlement of Malleable Cast Iron resulting from Heat Treatment," deterioration in the quality of malleable cast iron is found to result when the iron is heated to within a critical range of between 260 and 480 deg. Cent., and is then quenched, or cooled rapidly to lower temperatures. This deterioration is marked by a lessened ability to resist shock, and is encountered, for example, in the hot galvanised process. Its fundamental cause is not yet known.

An investigation of this phenomenon made at the Bureau of Standards showed a considerable variation in magnitude as between different samples of malleable iron. The impact method of testing was used, and was found to offer a very convenient means of measuring the degree of deterioration. The tests also showed that there is a fairly definite range of quenching temperatures to which the effect is limited. Ageing after heat treatment within the range did not affect the results. The rate of cooling was found to have an important influence, the degree of embrittlement being materially lessened if the iron was cooled slowly instead of being quenched.

If, on the other hand, the iron was heated to a temperature some 110 deg. above the critical range and quenched from that temperature it was found to be materially more resistant to shock, and it was also rendered immune to embrittlement as a result of subsequent reheating to within the critical range.

Patent Abstracts.

Particulars of Complete Specifications accepted, furnished by Mr. Eric Potter, Patent Agent, of 27, Chancery Lane, London, W.C.2, and Commerce Chambers, Parliament Street, Nottingham.

Printed copies of the specifications in the following list were on sale on January 24, 1924.

208,786. TAGLIAFERRI, L. Electric furnaces.

200,472. AMERICAN RADIATOR COMPANY. Mould-ramming machines.

208,834. APPLEYARD, K. C., MANNERS, W. E., BEWICK, P. W., LAYCOCK, SIR J. F., and PORTAL, M. R. Chill cores.

188,343. HARTMANN, J. Cooling-off process for annealing metals without damaging the finished surface.

192,386. CORADI, O. Electric annealing, hardening, and smelting furnaces.

204,688. HOLLEY, E. Application of lamp-black to metal moulds.

The Elimination of Structural Weakness in Castings.

We regret that in this article, which appeared in our January 3 issue, in Fig. 14, illustrating the persistency of cast structure, the micro-photographs have been transposed. The centre figure is the "as cast" structure, the bottom one is after forging and reducing to one half-size, and the top one after forging and reducing to one-eleventh of the original size.

MR. R. M. BAIRD, manager of the steel department of Thorne, Chapman & Company, Sydney (N.S.W.), and Mr. Charles Duckett, of the Melbourne firm of Edward Duckett & Sons, importers of metals, have left Australia on a business visit to this country.

MR. C. H. V. WILSON, formerly a representative of Messrs. Seebohm & Dieckstahl & Company, Limited, in Japan and the Far East, has been appointed representative for London and the Eastern Counties of Messrs. Wm. Cumming & Company, Limited, the well-known foundry facings manufacturers, of Glasgow, Chesterfield and other places. Mr. A. Hares, who for some time has represented the firm in a portion of this district, will now confine his attention to the South-West of England and South Wales.

XUM

The Practical Value of Modern Non-Ferrous Alloys.*

By S. F. Barclay, D.Sc.

Any particular alloy possesses two or more quite distinct qualities, and consequently may be employed for two or more quite distinct purposes. For example, phosphor bronze may be used purely on account of its capacity to resist corrosion or on account of its excellence as a bearing metal. It is impossible to develop in a maximum degree all the different qualities an alloy may possess, and, as a rule, any one quality can be given a maximum value only at the expense of sacrificing some of the others. The object of this Paper is to show that if the founder is to give the best service to his customers, he needs to know the exact use to which his castings will be put, so that he can bring out the relevant quality in the highest degree.

Phosphor Bronze.

If phosphor bronze is to be used for resisting corrosion, the greatest care must be exercised by the founder in keeping down impurities to a minimum. The zinc content should not exceed 0.25 per cent., and should preferably have a lower value; the lead should not exceed the same amount, and the iron and other impurities should not exceed traces. The function of phosphorus in castings to resist corrosion, is more to serve as a deoxidiser and a scavenger than as a hardening element, and it is satisfactory in such cases if the phosphorus content is about 0.25 per cent. In considering the action of impurities on phosphor bronze, it has to be remembered that in the solidified metal they are not uniformly dispersed throughout the mass, but tend to collect at the crystal boundaries, and an impurity which constitutes a small percentage of the whole may constitute quite a high percentage of the intercrystalline material. If the best results are to be obtained for resistance to corrosion, ingot metals only should be used or scrap from high-grade castings, the composition of which is known. Table I shows in a striking way the effect of what at first sight might be considered to be small percentages of impurities on the strength and ductility of the metal:—

TABLE I.—*Influence of Impurity on the Mechanical Properties of Phosphor Bronze.*

	Good quality.	Poor quality.
	Per cent.	Per cent.
Copper	89.68	87.56
Tin	9.78	9.3
Lead	0.08	1.53
Iron	0.03	0.23
Zinc	Nil	0.98
Phosphorus	0.235	0.117
Physical Properties.		
Yield point (tons per square inch) ..	9.0	9.26
Maximum load (tons per square inch) ..	20.2	12.62
Elongation on 2 inch	23.0	5.5
Reduction of area ..	27.5	6.0

If phosphor bronze is to be used as a bearing metal, the composition may be quite different from that previously described. This alloy owes its merit, as a bearing metal, to the presence of a hard skeleton framework of phosphor-tin with a soft filling of the other constituents. The harder the phosphor-tin eutectoid and the softer the filling, the more effective is the alloy as a bearing metal; the phosphorus content should thus be high, not less than 0.5 per cent., and with advantage it may be 1 per cent., and lead to the extent of 6 or 8 per cent. should be introduced deliberately to increase the softness of the filling.

Phosphor bronze is influenced profoundly by the casting temperature, as is shown by the figures given in Table II:—

TABLE II.—*The Influence of Casting Temperature on Phosphor Bronze.*

	Cast at		
	1,180 deg. C.	1,110 deg. C.	1,030 deg. C.
Yield point (tons per sq. in.)	10.2	9.0	8.52
Maximum load (tons per sq. in.)	11.60	20.2	12.0
Elongation on 2 in. ..	3.0	23.0	4.0
Reduction of area	3.8	27.5	4.5

In all cases where ductility of the alloy is of importance the temperature of casting must be carefully controlled. For bearing bushes, however, with which a low coefficient of friction is everything and ductility of minor importance, there is a distinct advantage in casting a metal somewhat cold.

Gun Metal.

The Admiralty specification is 88 per cent copper, 10 per cent. tin, and 2 per cent. zinc, with a maximum permissible lead content of 0.5 per cent. If castings are to be subjected to an elevated temperature such as is encountered with fittings for superheated steam, there is no question of the wisdom of limiting the lead content to the value fixed by the Admiralty. The lead in gun-metal is not diffused uniformly throughout the mass, but exists in the form of localised globules. At elevated temperatures the strength of the lead globules falls to zero, and their presence constitutes an important element of weakness. If, however, the gun-metal is to be used at ordinary temperatures, there is a distinct advantage in raising the lead content to 1 per cent., and there is nothing detrimental in employing as much as 1.5 per cent. The influence of lead on Admiralty gun-metal is clearly shown in Table III:—

FIG. 1.—STRUCTURE OF GUN-METAL AT 100 DIAS. TO BE ASSOCIATED WITH A GOOD METAL.

TABLE III.—*The Influence of Lead on Admiralty Gun-metal.*

Lead per cent.	Casting temp. deg. C.	Y.P. (tons per sq. in.)	M.S. (tons per sq. in.)	Elong. per cent.
0.19	1210	8.8	17.0	14.8
0.88	1215	10.1	17.6	16.8
1.50	1210	9.3	17.6	20.0
1.7	1220	8.2	16.4	13.7

It is clear from the above figures that if the founder is to produce the best gun-metal, he must

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* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. R. A. Miles presiding.

know if it is to withstand an elevated temperature or if it is to work at normal temperatures.

In common with most alloys, gun-metal is very sensitive to the temperature at which it is cast. If the metal is too high when poured, porosity is almost certain to result; if too cold, the metal will be weak and unsuited for withstanding pressure. For gun-metal to be sound and strong, it is necessary to have the interlaced type of structure, which can be secured only by casting at the correct temperature, which is approximately 1,200 deg. C. When poured at this temperature, the microscope shows that the interstices of the copper-rich mass of the metal are filled with small land-locked seas of eutectoid, and thus soundness results. Fig. 1 shows the structure required to give a strong metal. If poured at an appreciably lower temperature, there is a quick uniform contraction of the metal, which is more of a solid solution on account of the different constituents not having had the chance of separating out, and inter-crystalline pores develop as microscopic holes throughout the metal. If gun-metal is to be subjected to liquid pressure, annealing is of great value in causing dispersion of the eutectoid and the filling-in of the shrinkage interstices between the eutectoid and the filling.

Brass.

If any cold work is to be done on ordinary brass castings, it is desirable to increase the copper content and to keep down the impurities, iron, lead and bismuth, to very low values. If a higher tensile strength is required than can be secured by the plain 60/40 mixture, the 70/29 mixture with 1 per cent. tin gives good results. It has to be remembered that tin is only slightly soluble in 70/30 brass, and the addition of more than 1 per cent. is strongly to be deprecated. Further, it is most important that all castings of this alloy should be annealed very thoroughly if they are going to have any work done on them. Table IV shows the influence of annealing on the elongation and ultimate strength of naval brass:—

TABLE IV.—*Naval Brass* (62 : 37 : 1) *Annealed for* 30 mins.

Annealing temp. deg. C.	Method of cooling.	M.S. (tons per sq. in.)	Elon. per cent.
450	Quenched	29.0	19
550	Slowly cooled ..	28.0	30
550	Quenched	28.50	36
700	Slowly cooled ..	26.6	42
700	Quenched	25.6	50

If brasses containing a small percentage of tin are required to have good tensile properties, the lead content should be restricted to a low value. Frequently, however, alloys of this kind are specified with the essential requirements that they shall be "free cutting," have a good appearance, and be left with a clean, smooth surface after machining. For any metal to be "free cutting," there must be an absence of toughness and a marked tendency for the turnings to break off short. Excellent results of this kind are obtained by adding from 1.5 to 2 per cent. of lead to the brass. This serves as another striking illustration of the importance of the founder being given the exact information with regard to the metal quality required.

Castings for Electrical Conductivity.

There is now quite a big demand for copper castings for electrical work; the essential requirement is high conductivity, and mechanical strength is usually of minor importance. The founder should thus aim at securing sound castings with the highest possible electrical conductivity. Some deoxidising agent must be employed, otherwise the castings would be honeycombed with small holes. Boron is possibly the best deoxidiser, in view of its effectiveness and at the same time small influence on conductivity. It is of vital importance that all impurities be eliminated, as even very small amounts have an extraordinary effect in lowering the electrical conductivity; electrolytic copper in all cases should be used. Table V shows the effect of impurities on the electrical conductivity of copper castings:—

TABLE V.—*Influence of Impurities on the Electrical Conductivity of Copper Castings.*

	Added element. Per cent.	Electrical conductivity. Mathieson Standard.
Tin	0.38	73.0
Zinc	0.35	73.4
Nickel..	0.19	79.0
Iron	0.15	59.2
Manganese	0.12	71.0
Silicon	0.18	54.0
Chromium	0.04	91.5
Phosphorus	0.07	63.2
Aluminium	0.08	84.1
Magnesium	0.012	98.7
,, ...	0.024	94.0
,, ...	0.038	89.5
No addition	—	97.2

Another very important class of castings for electrical work is the slip ring used on rotary converters and other alternating-current electrical machinery. The slip rings are used for conveying the electric current from the windings of the machine to the electric cables and blocks of graphite or graphite associated with copper press against the ring under the action of springs. The demand of the electrical designer is that the slip ring temperature shall be as low as possible. There are two tendencies at work causing heating: the passage of the current through the ring and the frictional loss between the ring and the brushes. The ideal material would thus have high conductivity and low frictional loss. So far no alloy has been produced combining these qualities, and a compromise between the two has to be made. If pure copper is used, the heating due to the flow of current is small, but due to frictional loss, is unduly great on account of the unsuitability of the soft metal to withstand abrasion. If, on the other hand, a nickel-copper alloy is used, the frictional loss can be reduced to a small value, but due to the high resistance, the heating caused by the flow of the current is unduly great. Phosphor bronze is sometimes specified for this purpose, and, in fact, it is important for the founder to see that it is very pure in order to ensure high electrical conductivity, and that the phosphorus content does not exceed 0.05 per cent. in order to ensure that there is a minimum of the tin-phosphorus eutectic which would lead to undue resistance loss. Admiralty gun-metal is more frequently specified on account of its more favourable micro-structure. Lead should be eliminated altogether, and the zinc should not exceed the 2 per cent. specified, and preferably should be reduced to 1.5 per cent.

Castings to Withstand High Temperature.

Engineers often overlook the extraordinary way in which some non-ferrous alloys lose their strength when subjected to even small increases of temperature. Most brasses have less than one-half their original strength if heated to 350 deg. C., and at 450 deg. C. the tensile strength has fallen to one-eighth the normal value. Table VI shows the relationship between temperature and strength of some of the better-known alloys:—

TABLE VI.—*Relationship between Temperature and Strength of some Non-ferrous Alloys.*

Alloy.	M.S. (tons per sq. in.)			
	200 deg. C.	250 deg. C.	350 deg. C.	450 deg. C.
Muntz metal ..	31.6	23.1	12.7	3.9
Cast manganese brass	33.1	23.2	12.8	4.2
Drawn manganese brass	35.1	23.1	12.2	2.8
Delta metal, 4 E.	23.1	28.4	19.1	17.5
Cast gunmetal ..	16.1	15.2	10.1	5.4
Cast phosphor bronze	15.3	14.8	10.9	10.2
Nickel copper ..	16.7	13.3	11.6	11.1
Monel metal ..	39.2	36.1	35.8	31.3

The aluminium alloy piston for internal-combustion engines well illustrates the importance of the founder knowing the use to which the castings will be put. An aluminium alloy is not used for

pistons, purely on account of its low weight; in fact, for the medium-speed motor-car engine, the greater weight of cast iron in itself is an advantage, although such is not the case for very high speed engines of the type used on racing cars and aeroplanes. The most important reason for using aluminium pistons, however, is the better heat conductivity as compared with cast iron. If the correct alloy is used, it is possible for the heat conductivity to have over double the value of that of cast iron. With most aluminium alloys there is very rapid falling-off in strength with increase of temperature, but special alloys have now been produced which retain a fair measure of strength at the working temperature. Another important feature of alloys for this purpose is that the thermal expansion shall be as low as possible.

The Hot Working of Steel.

Dr. Percy Longmuir on January 17 gave a lecture of a practical type before the Staffordshire Iron and Steel Institute, at Birmingham University, on the subject of "Effects Occurring in the Hot Working of Steel." He explained that for the purpose of the lecture he had taken advantage of the courtesy extended to him by two leading Sheffield firms whose workmen had under his instructions treated steel samples in various ways. The results were shown diagrammatically, in the way of tensile and other tests, and micrographs were exhibited illustrating the changes in the constitution of the metal at various stages.

DR. LONGMUIR said that every worker in hot or molten metal had to deal with difficulties arising from air bubbles, and all sorts of different results arose from the varying temperatures at which metal was heated. Although many text-books gave formulæ for heating, the correct temperature must vary with the metal employed, and the section dealt with. No text-book could give the correct temperature for any given alloy or metal; it all depended on the section to be made. The same principle applied to annealing in connection with the white iron used in malleable castings. Steel was extremely difficult to superheat, without introducing at the same time disturbing conditions. It was possible with steel to get very different effects in tensile tests merely by varying the heating. The effect on the packing of crystals was such that practically any range of structure could be obtained by heat variations alone. Incorrect heating with the best Sheffield steel was very apt to develop a crack in the centre of the bar, which would not be removed in all the subsequent operations, and was very liable to contain ferrous oxide. When that was subjected to cold rolling, the result was hopeless.

Another effect frequently met with was the development of soft patches in such products as milling cutters due to decarbonisation before the cutter was worked. Slag inclusions were a fruitful cause of breakdown in cold-worked material, and in the case of wire rod, segregation in the centre produced a lot of failures in wire, this often being due to extreme heat. Discs of 18 per cent. tungsten steel were often burst in the centre by bad forging, but they were sometimes ruined by overheating.

Probably Midlanders did not quite realise the enormous development that had taken place in the cold-working of steel, though he did not accept the statement that the drop-forger would oust the foundryman, who would still be called upon to supply intricate castings. Cutting steels were now being lathed at a very high rate of speed, this severe treatment making greater demands on the quality of the steel; that quality was generally improved where oil-quenching was substituted for water-quenching. An alloy containing 5 per cent. nickel with 0.2 per cent. carbon was formerly much favoured for crank-shafts, and gave very good results in impact and elongation tests. Iron-chromium alloys were being developed in steel works to a considerable extent, and there were equal possibilities of extension in ironfoundries, if the necessary amount of experimental work could be undertaken.

The mysterious cuppiness sometimes found in wire was usually due to a bad centre which in drawing refused to follow the outside flow of the metal.

In his reply to the discussion Dr. Longmuir said the most useful results were those obtained in practice, rather than under laboratory conditions, and the experimenter should always be prepared completely to change his ideas as the result of experience. He remembered saying once that the microscope could solve all their problems, but he now considered that no single method would serve. With regard to soft spots in gudgeon pins, referred to by the President, Sheffield workers were very familiar with them; in most cases it would be found they were due to decarbonisation in the previous working of the metal.

Speaking of wire-rope breakdowns, Dr. Longmuir said that if he had been speaking two months earlier he could have said that no miner had ever lost his life through the breaking of a wire rope. Unfortunately, the accident at the Nunnery Colliery, Yorkshire, involving loss of life, had broken that record. But he still hoped that when the investigations were complete it would be found that the accident was not due to the failure of the rope itself, though there was always danger from the over-drawing of wire; the margin was narrow between safety and over-drawing. Fortunately, from the user's point of view, the narrowness of the margin was a safeguard, since the defect was instantly shown in practice.

Canadian Mineral Production in 1923.

The mineral production of Canada advanced about 12 per cent. in 1923 to a total of $214,102,000 as compared with $184,297,242 in 1922 and the record value of $227,859,665 attained in 1920, according to a statement issued by S. J. Cook, chief of the mining branch of the Dominion Bureau of Statistics, Ottawa, who has just completed a preliminary survey of the mineral industry. It is pointed out that commodity prices, which reached a peak in 1920, have since receded, and this fact must be borne in mind when production is computed in terms of values. A weighted index showing the volume of production would undoubtedly mark 1923 as the banner year in Canada's mineral industry.

New output records were established for coal, lead, zinc, asbestos, and the total value of cobalt. Copper production was more than double the tonnage produced in 1922, and nickel increased practically three and one-half times. Gold and silver were slightly lower than in 1922. A group of non-metallic minerals, including about twenty commodities, increased two million dollars to a total of $19,000,000. Structural materials and clay products including portland cement showed little change in the aggregate value, the total for the year being estimated at 38.9 million dollars.

Jubilee of Trade Paper.

We have this week pleasure in congratulating our esteemed contemporary, "The Hardware Trade Journal," on reaching its jubilee issue. It was started in Birmingham in 1874, and has rendered sterling service to the trades it serves. It celebrated the event by the publication of a specially enlarged number.

ACCORDING TO THE LIST of company registrations at Somerset House in 1923, compiled by Jordan & Sons, Limited, the total registrations of companies in 1923 (8,005) slightly exceeded in number those of 1922, but the new capital shrunk from £120,999,585 to £106,963,215, a difference of 14 millions. Iron, brass, etc., companies to the number of 361, with a capital of £3,365,975, were registered, and engineering concerns totalled 430, with a capital of £5,082,582. In regard to mining companies, the number of registrations last year was 251, and the capital £13,840,138. No distinction is made in this compilation as to whether the mining concerns are coal, ore, gold, etc., or whether they operate in this country or abroad.

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New British Standard Axle Box.

Since the introduction by the railway companies of this new standard axle-box, there has been considerable interest displayed by a number of founders as to the most economic methods used in the rapid production of these castings. The general design is of years' standing, the box being made in two halves with a very irregular male and female joint running around the joint of each half-casting, and the lower half has the addition over the old type of a thin curved web of metal joining up to the sides and ends of the casting. A hole having a turned-down lip is formed in the centre of the web to accommodate the lubricating pad, and below is the oil well formed by the intervening web of metal.

The core which forms the oil well is an important factor, because it is completely surrounded by hot metal, and when cast and cleaned, the oil well must be a perfectly clean and non-porous cavity on account of it being used as an oil supply to the lubricating pad for the journal part of the wheel axle. The elevated ridge of sand which forms the irregular groove in the face of the lower half-casting is plainly shown in Fig. 1 and marked B; this ridge is of green sand and made simultaneously with the main green-sand body-core. It is quite safe, and does not wash when the metal is poured into the mould; no sprigs are used to support it, therefore considerable time is saved by the method indicated over that in which small right and left dry cores are used to form this groove. These axle-boxes are not machined on the joint; therefore, they are cast joint down, thus producing a nice clean face. The upper half-casting is a fairly heavy piece, but does not present any difficulties; the green-sand body-core box for this part is shown in Fig. 1, and the thin deep pocket for forming the dust-guard groove is clearly seen, and is formed integral with the main green-sand body-core; a dry-sand core for lightening purposes is secured in this upper half-mould below the spring seat; it is secured by a cotter-pin passing through the core iron and wedging against the edges of the box bars. This procedure eliminates the use of nails in the walls of the mould. Two small projecting horns on this core form drain holes through the two opposite sides of the casting.

The illustrations show the jarring turnover machines specially adapted for moulding these castings, that shown in Fig. 1 being used for making the green-sand cores for forming the inside of the axle-box castings, whilst the machine depicted in Fig. 2 is used for making the moulds. Included in the two illustrations are the two half-castings, two completed moulds, one complete green-sand core part, core boxes, complete patterns, and an upper and lower half-casting bolted together and sawn through, thus showing the various thicknesses of the metal in each half-casting. These sectional castings are shown in Fig. 2 and marked A.

The design of this axle-box tends to its rapid production in the foundry, and the advantage of being able to make the main body core in green sand dispenses with the cost of drying the cores and the extra labour used in carrying them to and fro to the core ovens. The oil-well core must of a necessity be a dry-sand core, but it is little more than a flat slab of sand and very applicable for moulding on a small jarring machine.

Whilst it is generally appreciated that the actual time for jar-ramming a mould is but a few seconds, the maximum output from a machine depends upon other factors, such as the convenient storage of the moulding boxes, the conveyance of sand to the machines, the rapidity with which moulds can be taken away from the machine and closed, the setting of dry-sand cores, if any, in the mould, and the quickest and safest methods of securing those cores if hanging. In fact, quite a number of small details other than just making the moulds and green cores, that crop up in the day's work and which must be overcome in such a manner as to produce a well-organised system, so that the sequence of operations must follow in correct regularity, ensuring a continuous and rapid production of the necessary moulds and cores. The machines will ram the moulds quickly enough and draw the patterns, but the piecework or day-work question, and the man-handling of the completed moulds, is a matter for the master founder himself. The machine cannot possibly control that part of the day's work. The whole sequence of the operations of making, coring and closing these moulds for these new standard axle-boxes can be seen at the works of the makers, Messrs. John Macdonald & Son, Limited, Watt Street, Maryhill, Glasgow.

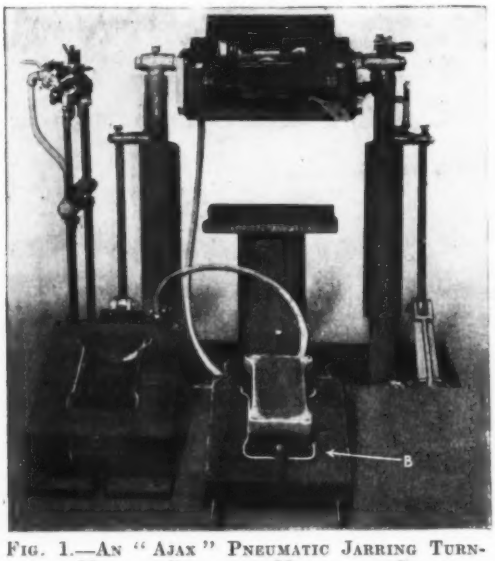

FIG. 1.—AN "AJAX" PNEUMATIC JARRING TURNOVER MACHINE SET UP FOR MAKING THE CORES FOR THE NEW BRITISH STANDARD AXLE BOX.

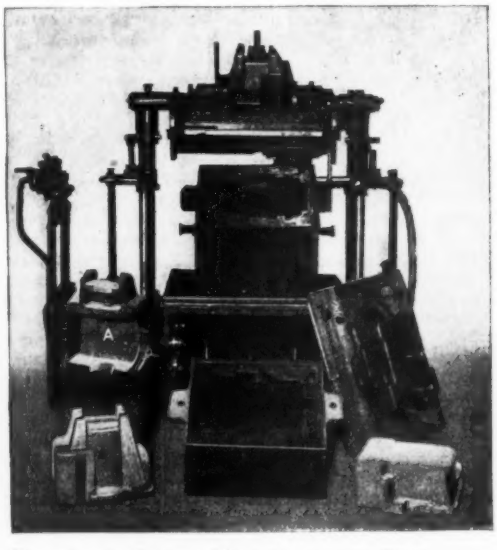

FIG. 2.—A SECOND MACHINE WHICH MAKES THE MOULDS.

New Ore-Shipping Plant at Melilla.—The iron-ore shipping plant which is to be installed at Melilla will be of rather unique construction. Underneath the ore dump will be built five tunnels, containing belt-conveyors 40 in. wide by approximately 850 ft. long. The ore will be fed into these conveyors from above, and, in turn, these will feed two shuttle-conveyors arranged at right angles to the tunnel, and which will feed on to a further conveyor running along the pier. This last conveyor will work in conjunction with a travelling ship-loading tower to deliver the ore into the ship. This plant is being manufactured by Messrs. Fraser & Chalmers, Engineering Works of the General Electric Company, Limited.

A Day at the Cupola.*

By A. R. Bartlett, M.I.Brit.F.

This subject is obviously of interest to every foundryman connected with the production of iron castings. A day at the cupola may seem a short time, and possibly appears to hold little interest, but it can be stated that the day to be described is quite a usual event in the foundry with which the author is connected, and one that is sufficiently strenuous to satisfy the most energetic of men. It requires the utmost care and keen supervision to keep the cupola continuously occupied and getting all the jobs ready in their proper sequence. Additionally one must plan, so that the cupola charges the corresponding jobs run concurrently. To do this the foundryman must be properly equipped and be assured that everything is working in good condition.

Melting Practice Outlined.

To the onlooker, melting iron in a cupola is a simple operation. Coke and iron are arranged in alternate layers until the cupola is filled to the charging door. Air is driven in to promote rapid combustion. An intense heat is developed which melts the iron, which drops to the bottom and runs out into a ladle. When the ladle is full, a man pokes a bit of clay in the tap-hole and stops the stream. As the metal is melted and taken away, all that it necessary is to keep putting more iron and coke in at the top, and it continues running out at the bottom. Charging is discontinued when the weight required has been melted. That is all there is to it. To those unfamiliar with foundry practice, nothing could be more simple, yet the foundryman who has studied the subject knows that unless the closest attention is paid to every detail the cupola can produce more trouble in the foundry than any other factor entering into the production of castings.

Foresight Necessary.

Primarily it is useless arriving at the foundry in the morning and then beginning to realise that there is between 40 and 50 tons of metal to melt and cast before the proper leaving-off time. An efficient foundry manager must visualise his work for some time ahead, so that he has decided on which day certain jobs will be cast, and thus avoid having a quantity of work to cast on one day and very little the next. Though having planned in this manner, it is additionally necessary to ascertain that the moulds for the day's work are all dried, if using dry sand or loam, and in the case of green-sand jobs sufficiently advanced to be finished in time to take the metal as required. Cores and all holding-down bars, weights, etc., must be arranged so that no one job interferes with the progress of another. Having reached the conclusion the day before exactly what metal will be required, it is necessary that this is on the stage or in the most convenient position for the proper supply to the men charging the cupola.

The Particular Cupola Described.

Knowing that the cupola must be ready for charging by a certain time, the necessary men must start work at a suitable time. In the case of the cupola under consideration, the men had to chip down from the previous melt and repair the cupola. This made it needful for two men to be in at midnight, as the charging had to commence at 7.45 a.m. The foundry was able to do this, having more than one cupola, and working them alternately. Additionally, the men work in shifts.

The cupola used in this description is 3 ft. 6 in. inside the brickwork, having a double row of tuyeres evenly divided. There are six of 8 in. dia. on the top row and four of 5 in. on the bottom row. The tuyeres are staggered; that is, the top row are placed at intermediate distances above the bottom row, so that no two tuyeres are in a perpendicular line. Thus the air is delivered evenly over the whole area. Also by this way of distributing the air it does not strike the wall opposite the tuyere, in which case it would have a cutting effect, destroying the wall and causing increased costs for repairing for the next melt and giving excess slag to be dealt with over and above the normal amount given off from the raw materials. Some cupolas have the tuyeres arranged in spiral fashion around the wind belt, thus giving each inlet a free line across the cupola, striking the opposite wall, and causing the cutting effect described. It may be thought: How can this happen when the cupola is working, as it is filled with coke and iron dropping down in a molten condition? But it must be remembered that the coke does not form a solid mass, and the molten metal does not fill up the spaces between the coke above the well; therefore, if the pressure of air is on it must penetrate to the opposite wall and then travel upwards to the only outlet, that is, the opening at the top of the stack, cutting the brickwork in its passage.

In the cupola described the air is delivered from the blower through a 16-in. dia. pipe into a wind-belt, the pipe entering it at an angle in line with the radius of the belt, and not at right angles, as most cupolas. This gives a circular action to the air round the wind-belt, and has the effect of delivering a softer blast through the tuyeres than would occur if driven direct into them.

A M.1 Roots blower is in use, running at 330 r.p.m., delivering about 6,000 cub. ft. of air per min. It is situated 80 ft. from the cupola, and is installed in an engine-room free from the dust of the foundry. This is most certainly an advantage, as dust has been known to gather in the blower and cause wearing on the blades, and thus losing its efficiency. Many advocate that the blower should be as near the cupola as possible, but with the correct pressure and a sufficiently large delivery pipe this is not essential. So long as the correct volume of air is delivered to the cupola, it will melt the metal in a given time, with the correct amount of coke. Each furnace has a pressure-gauge, the reading being taken on the wind-belt. A pressure-gauge is also installed on the air-delivery pipe between the blower and the cupolas. By these means it can be determined whether the blower or other cause between it and the cupola is the reason for any alteration in the pressure, or whether the alteration is through some altered condition at the cupola itself.

Blast Pressure.

Pressure should only be sufficient to drive the air in sufficient volume into the cupola to obtain perfect combustion. Pressure is merely force required to overcome resistance. But it is not always advisable to imagine that the correct volume of air is entering the cupola through the tuyeres, even though the pressure-gauge on the wind-belt remains constant. For if there is a clear passage for the air entering the furnace and the charges are not properly packed the resistance is lowered and the pressure appears less, whereas if the front of the tuyeres are choked the pressure appears greater, and records as such, but under the circumstances a lesser volume is entering the cupola, and combustion and melting are less efficient. Actually a given amount of air is required to melt a given amount of iron in a given time. Therefore, volume is more important than pressure.

It is usual with most foundrymen to measure all coke, metal and flux charged into the cupola, but there are many foundries where no means of measuring the volume of air is available.

It is not realised how important the correct volume of air fed into the cupola has a bearing upon the resultant metal. Control of air is a real necessity. Foundrymen must be able to obtain the correct volume to get the ideal conditions from the cupola, and must have means of controlling the volume of air to maintain constant the ideal con-

* A Paper read before the London Branch of the Institute of British Foundrymen, Mr. V. C. Faulkner presiding.

ditions when found. This can only be done by measuring the volume of air and by having some means of exhausting any excess, or by altering the speed of the blower. An excessive or an insufficient supply of air has been proved to have an entirely different effect on the resultant analysis of the castings made from what has been expected from the grade of metal charged. Also, the air supply affects the consumption of coke. A foundry may be buying high-grade material and spoiling it by using an incorrect volume of air. With an insufficient supply of air, fuel is wasted; on the other hand, an excessive supply of air and high pressure has the effect of oxidising the metal.

Preliminary Work.

The day's work started with an empty cupola, on which no previous preparation had been done, it being in the same condition as when the bottom was last dropped.

As soon as the furnacemen arrived, one of them was able to start chipping down the slag adhering to the sides of the cupola from the previous melt, as the cupola had been resting for 36 hours. While he was doing this his mate was mixing the ganister to the right consistency for the subsequent patching, and gathering some old firebricks for filling any unusually deep holes worn in the lining. The cupola, having a drop bottom, also needed a fresh supply of sifted sand for renewing the bottom. This also he prepared while his mate was doing the chipping down. This work brings the operations of chipping down and preparing materials about level. The man inside the cupola then commenced patching, his mate outside handing in the ganister and broken bricks as required. For this operation it is always advisable to mend the damaged and burnt parts, so that the inside of the cupola is fairly parallel from top to bottom. Under no consideration should any abrupt hollows or projections be allowed, as this is a very probable cause of bridging. The charges become jammed, and no further charging can be done and melting ceases. When the whole of the region requiring patching was done, the tap-hole was put in.

The Tap Hole.

This is an operation which must be done with great care, and efficiently. This, if made carelessly, will probably lead to much trouble. Knowing from experience the size of the tap-hole necessary to allow the metal to flow at the same ratio as charging and melting takes place, an inch round stick is kept for building round. Both the inside and the outside of the tap-hole are tapered, so that the actual passage or tunnel 1 in. in dia. is only about 2 in. long. The taper inside the cupola is much longer and less acute than the taper in front of the hole. The tap-hole was made up wholly of ganister. The reason for the taper inside the cupola is to allow of a sufficient volume of metal to lie inside before tapping, to avoid a set tap-hole. This cannot be corrected, no matter how the hole is forced and subsequently patched. Besides which, if successful in breaking through, a loss of time occurs, and the metal becomes dull through the blast having to be shut off, while this is being carried out. The result is obviously the production of faulty castings. Additionally, during the rest of the blow trouble is experienced through the patched tap-hole breaking away again most probably, and again needing patching.

Preparing the Hearth.

Having finished the tap-hole, the drop bottom was next fixed in position and the sifted sand thrown in through the bottom door for ramming, the one man doing this, while the other feeds the sand in as required. The sand bottom is rammed firmly to about 6 in. above the bottom plates and level with the tap-hole, having a slant from front to back of about 1 in. That is to say, 1 in. lower at the tap-hole than at the back of the cupola, or farthest point from the tap-hole. This is to facilitate the flow of the metal to the tap-hole, and to ensure that at the finish of the day's melting no metal shall be laying in the bottom, otherwise when the bottom is dropped the metal so left is liable to splash and probably burn someone; besides which, it would cause unnecessary expense in melting metal that is not wanted, or possibly it may necessitate leaving some job uncast, when just that drop in the bottom would have given sufficient for the purpose.

The bottom being finished and the tap-hole cleared from the inside, the operator made the correct taper at the tapping spout on the front of the cupola, and then inserted hot bars in the tap-hole until the whole of it was thoroughly dry. This is essential, as otherwise the metal when coming in contact with a damp tap-hole is liable to blow, and the metal cooled and becoming set there. The slag-hole and tapping-spout are also made and dried.

Lighting the Cupola.

The next operation is to lay the fire. This was done by laying wood on the bottom of the cupola, having first placed a large piece of hard coke behind the tap-hole, to prevent any small pieces of coke from falling down there and obstructing the free passage of the molten iron. The wood, as far as possible, is put in from the bottom at the back door. The doorway is then built in with large pieces of coke, and a prop placed against the coke to prevent the subsequent weight of coke from forcing it out. The furnaceman then continued from the charging floor, and dropped wood if needful into position, and then sufficient coke to form a good base fire. Before lighting the fire the furnaceman ascertained that all the peep-hole doors at the tuyeres were open. This is to allow the air to be drawn in to help combustion, as well as the air entering at the back door. He then procured a hot bar, which he placed through the coke at the back door, and thus set light to the wood. Sufficient time being allowed for this to light up well, and the coke having caught and burnt up well, sifted sand was rammed into place behind the coke wall at the back door, and the back door bedded solid against the rammed sand. When satisfied by taking down the door and seeing that it is solidly bedded, the door was again placed in position and securely fixed with cotters, so that there was no possibility of any break-away. The bed charge of coke was next put on. This was 9 cwts. This is determined by the height of the tuyeres from the sand bottom. The coke was carried up to about 18 in. or 20 in. above the top row of tuyeres. The coke bed was now allowed to burn up well. If, when ready for charging, the fire has not burnt up sufficiently, the blast is put on for a few minutes to assist combustion.

Botting.

Having decided that the coke was well alight and that the tap-hole is thoroughly dry, the furnaceman fixed a rest across the tapping-spout. This is to assist him in botting in over large ladles. The bot stick used, necessarily being a long one, cannot be controlled from one extremity to the other without some intermediate rest, and the man, of course, cannot put his arms over a large volume of metal for the purpose. Botting is done with a mixture of fireclay and blacking, this being ground in a mill to ensure being fine and sufficiently adhesive. To assist the clay bot to adhere to the bot stick, the stick is dipped into water, the water also cooling the end of the stick after being in contact with the hot metal at a previous operation. When the operator was satisfied that the bot was secure on his stick he dropped it into dry blacking. This is to avoid as far as possible the stream of metal being frozen to the bot and thus forming a hard skin surface, to be broken when tapping again takes place. The furnaceman next ascertained that all the peep-hole doors at the tuyeres were closed, and that the tuyeres were in proper position for the blast to be put on.

Charging Operations.

The furnace is now ready for charging. There was altogether 50 tons of metal to melt and pour, and four different mixtures to be produced. the first mixture taken being 10 tons for casting a cylinder, the next being a semi-steel mixture of 6½ tons, followed by 20 tons suitable for heavy mill work, the remaining 13½ tons being what we term our ordinary mixture. The cupola takes five 21-cwts. charges to fill before the blast is put on.

Closed Tap-Hole Practice Described.

Having charged the cupola level with the charging-door, the furnaceman then ascertained that his

tap-hole was clear and thoroughly dry. He then mixed some weak facing sand with a small quantity of charcoal-blacking, and rammed the hole, softly in the tunnel and more solidly at the front, with this sand mixture. This is not always the practice with every cupola, but in this particular foundry the management invariably take the largest jobs first, as they desire to get the well filled before tapping. Also, if the blast is put on with an open tap-hole there is a liability of the drops of metal first melted falling into the bottom of the well and being cooled by the passing blast attracted to the open tap-hole, whereas if the tap-hole is closed the attraction for the whole of the blast is the shaft at the top of the cupola. This leaves the metal on the bottom in a liquid state amongst the hot coke, where it is rapidly joined with the following metal melted. Again, whatever fluxing material may be in use it melts at a lower temperature than the metal; therefore, it must reach the bottom of the cupola before the molten metal, and if the tap-hole is left open the flux is very liable to be blown into the open tap-hole, where it would very rapidly solidify. Even if it did not choke the tap-hole it would solidify on the bottom of the cupola through the cooling effect of the blast, and then later on would probably melt again when the hot metal accumulated above it, giving an excess of slag to be dealt with in a region of the cupola where no provision is made for taking slag off. The probability is that the slag so melting off the bottom would flow out with the metal and enter the ladle, giving trouble to remove it, or perhaps getting trapped in the metal, and, entering some mould, spoil the casting if it had to withstand pressure test. Those who advocate the open tap-hole claim that no flux should be put on with the first two charges, owing to the risks mentioned. But if flux is needed to clean the metal in later charges, what is to clean the first two charges if no flux is put on?

Melting Operations.

After the tap-hole is rammed the furnace is ready for the blast to be put on, which was the next operation. It takes about 20 minutes from the start to get the well sufficiently full for tapping, approximately this being about one ton of molten metal. The sand rammed in the tap-hole is now removed by the usual method—with the tapping-bar—and if the cupola is working as it should the supply of metal from the melting zone is sufficient to keep a continuous stream for the whole of the ten tons required for the first cast. Naturally, the charging of the cupola must be in ratio with its melting capacity, and the tap-hole also, as before mentioned, be of just the correct size to deliver the metal in the ladle as fast as it is melted. If the tap-hole is too large, it has to be stopped, while the metal collects again in the well, and then needs re-tapping when considered sufficiently full to justify the operation. The safest way to assure oneself that the time has arrived for re-tapping is to have the slagging hole sufficiently below the tuyeres to avoid any possibility of metal getting into the tuyeres without first showing itself at the slagging-spout. The slag hole is tapped when the furnace has delivered about five tons of metal into the ladle. From experience with the cupola it has been found that the slag has accumulated in sufficient quantity to justify the opening of the slag-hole at this time, otherwise it would be rising, and would rapidly choke the tuyeres. When the metal is seen to trickle from the slag spout it is then known that the metal has filled the well to that height, and must be tapped out at the spout, otherwise metal will be lost and possibly rise rapidly and choke the tuyeres.

Double Coke Charges to Separate Metal Burdens.

As the furnace is melting four distinct and different mixtures of metal in the cupola, and in the endeavour to ensure that they do not get mixed, a blank charge of coke is put on the cupola between each different mixture. By this is meant that when the ten tons of cylinder metal is charged a hundredweight and a-half of coke is put on before the next charge of metal, coke and flux. This operation is repeated between every distinct mixture. As there is always a probability of the different charges getting mixed, it is advisable to charge an excess of each mixture required for any specific job and to take this excess of the first one and a portion of the second one off into a ladle and use it for casting some job that you know will not be inefficient, no matter what grade of metal is used. This is always possible where a variety of castings are being made.

The ordinary charge put into the cupola consists of 21 cwts. of metal, 1½ cwts. of coke and 1 cwt. of flux. Chalk is the flux employed. To ensure that the charges are weighed, a weighing-platform is installed in the charging floor at the discharge door of the lift, which takes the materials from the ground to the charging floor. It is useless having the quality of materials tested if the quantity of all materials charged are not carefully supervised, to ensure good castings. It cannot be expected to be able exactly to repeat conditions day after day if care is not exercised in this way.

Having produced the quantity of the first mixture required, it is now necessary to ease the delivery of the volume of air entering the cupola, as the time taken up with lifting the one ladle out from under the tapping-spout and putting in the next ladle means that if the furnace continued to melt at the same ratio all the time the metal would be running out of the slag-spout, or possibly rising sufficiently fast to enter the tuyeres. This obviously would be a loss, besides choking the tuyeres for the rest of the blow and retarding efficient combustion and melting.

To check the supply of air there is a valve on the air-delivery pipe which can be opened or closed as required, the air not required exhausting into the atmosphere.

The next ladle required being in position, the blast is again put on by closing the exhaust valve on the air-delivery pipe, and the metal allowed to gather till the well is full, this being determined by seeing the metal trickle from the slag-spout. These operations detailed are repeated with every exchange of ladles. If it should happen that when the metal is delivered into the ladle that the job it is intended for is not quite ready, a good covering of charcoal, small coke breeze or blacking is put on to ensure that the atmosphere is not unnecessarily cooling the contents. It is infinitely better to do this than to ease the blast and retard melting, as the metal so retarded does not come from the cupola in a good fluid condition, and the metal can be kept much hotter in the ladle than by laying in the well of the cupola, where it is absorbing sulphur from the fuel. It must be remembered that there is a drop in temperature between the melting zone and the well, and the faster the metal is received into the ladle from the melting zone the longer it will remain hot and fluid.

Final Stages.

Having finished charging all the metal wanted, and as the metal becomes lower in the cupola, the volume of air can be reduced with advantage, because the continual heat generated during the blow has been absorbed by the wall of the cupola, and the heat thus given off helps materially in keeping the fuel and metal in a live and hot condition. Also it must be remembered that as the metal becomes lower in the cupola the resistance to the pressure is lowered and the effect of a continued full blast is a driving-in of an overload of oxygen through the fuel and metal, having the oxidising effect on the metal. This is why it is ofttimes found that the later charges received from the cupola produce hard metal.

The last ladle being under the tapping-spout, the foundryman must be sure that all the metal is drained from the cupola. The blower can now be stopped and preparations for the dropping of the bottom proceeded with. The stream of metal having ceased to flow, which can be determined by seeing the weakening of the stream and observing a small stream of slag following. The final bot is now placed in position to ensure that no more slag can come into the spout and into the ladle.

Dropping the Bottom.

The furnaceman now goes behind the cupola and removes the cotters from the back door; next he lifts away the back-door plate and pierces the sand which was rammed into position to ensure

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the solid packing of the plate at the bottom level with the base of the well. This is to give any metal that has hung round the coke or wall an opportunity of getting away before actually releasing the bottom doors. This is essential, as any metal so left is liable to splash and probably burn some of the men. Having assured himself that no more metal is likely to flow, the furnaceman now drops the bottom doors, and the whole of the contents of the cupola fall on the ground directly under the cupola. This mass of hot coke and slag must be separated while in a plastic state, otherwise, if left till the morning, it would be a solid mass, necessitating much hard work in breaking. Water is played on this hot heap, cooling the outer surfaces, thus enabling the men to approach, who, with bars and rakes, disentangle the mass, so that in the morning it can be readily handled and separated. The coke is retrieved and used again the next day for the later charges, when the cupola is hot. With the dropping of the bottom and the cooling and raking apart of the fallen mass, the day's work is over.

In conclusion, it is emphasised that the chief object of present-day cupola practice is to produce metal in the correct fluid condition for the work in hand, with the least cost consistent with good results, and this in the shortest time possible. These are to be associated with an endeavour to alter as little as possible the mixture delivered from that charged into the cupola.

The temperature of the metal when being cast should be that which is correct for the job in hand, and not always just as delivered from the cupola. Remembering that the usual temperature of metal as leaving the cupola is about 1,400 deg. C., and that by the time it drops from the spout into the ladle it has lost approximately 15 deg., then again a loss of heat amounting to another 40 deg. in the ladle while receiving its load if about three tons. Again, if the metal is poured from ladle to ladle, a further loss of heat takes place, probably in the region of another 40 deg. to 50 deg. for each such pouring. Consideration should be given to the fact that in pouring several jobs from one ladle a loss of heat takes place with every separate operation of pouring and turning back the stream of metal. Therefore, each job must be considered on its merits, and an endeavour should be made to pour it at the temperature most suitable for the job in hand. With the ladle of metal used for several jobs, cast the one first needing the hottest metal, and the last drop of metal into the job most suitable for the dull metal.

Contracts Open.

Cardiff, February 6.—Providing and laying 700 yards of 4-in. cast-iron water main, for the Cardiff Rural District Council. Mr. W. Farrow, Park House, 20, Park Place, Cardiff.

Harrow-on-the-Hill, February 2.—New eight- or ten-ton compound steam roller, for the Urban District Council. Mr. J. Percy Bennetts, engineer and surveyor to the Council.

Keighley, February 2.—6-in. cast-iron socket and spigot pipes to British standard specification class C, for the Corporation. Mr. M. Ratcliffe Barnett, Town Hall, Keighley.

Wentworth, N.S.W., February 11.—Seven steam hoisting engines and three steam swinging engines, for the Department of Public Works, New South Wales. The Department of Overseas Trade.

THE DANISH MACHINE COMPANY, LIMITED, have removed their offices to 11, Queen Victoria Street, London, E.C.4.

OWING TO THE development of further lines of foundry specialities, the Pneulec Machinery Company, Limited, of Smethwick, Birmingham, are doubling their present capital.

MR. OLIVER SMALLEY, technical adviser to the directors of Sir W. G. Armstrong, Whitworth & Company, Limited, has resigned that position. We understand that Mr. Smalley is establishing himself in business as a consulting metallurgist.

MESSRS. F. H. LLOYD & COMPANY LIMITED, steel founders, James Bridge Steel Works, nr. Wednesbury, are increasing the area of their foundries by the addition of a new bay to deal with the increased business which is being offered. The work will be completed about the end of April

Obituary.

MR. H. E. WARD, of Ward & Payne, edge tool manufacturers, 14, West Street, Sheffield, died recently.

MR. S. BECKWITH, manager of the Glasgow Iron and Steel Company, Limited, died recently after eleven years' service with the company.

MR. HARRY PEARSON, iron merchant and agent, Orchard Chambers, Church Street, Sheffield, has died at Bridlington following an operation.

MR. J. NOEL, founder of Noel Bros.' Sanitary Pipe Works, Pontyclun, which were taken over about fifteen years ago by Mountford, Phillips & Company, Limited, constructional engineers, died on Thursday of last week at the age of 78 years.

MR. C. S. KINCAID died suddenly on January 19 at Corrie Bank, Greenock, aged 73 years. The deceased gentleman was formerly associated with John G. Kincaid & Company, Clyde Foundry, Greenock, and was the fifth son of the late Mr. Thomas Kincaid.

MR. F. NEVILL, J.P., of Glyncoed, Llanelly, died on Monday. Mr. Nevill, who was 73 years of age, was the managing director of the Wern Engineering Works, Llanelly, and was highly respected in the commercial life of the town. He was the eldest son of the late Mr. Richard Nevill, who was the founder of the firm of Richard Nevill & Sons, Wern Engineering Works. The deceased gentleman was connected with this firm during the whole of his business life. He was President of the Welsh Engineers' and Founders' Association.

SIR GEORGE BEAN, who died on Wednesday, at his residence at Dudley, aged 68, was chairman of the firm of Harper, Sons & Bean, Limited, and was associated with other large industrial concerns, including the chairmanship of Allen, Everitt & Sons, Limited, and Manning, Wardle & Company, Limited. The son of Mr. Thomas Bean, Sir George began his business life as a bank clerk. He had taken an active part in local municipal work, and was an alderman of Dudley, holding the office of Mayor during three years. He was knighted in 1919.

MR, J. W. BROOKE, J.P., chairman of J. W. Brooke & Company, Limited, engineers, etc., Lowestoft, died on Saturday last in his seventy-fifth year. Mr. Brooke, who was born at Redbrooke, near Barnsley, was educated at Charterhouse and afterwards became an apprentice to a foundry and engineering works in London, eventually going to America for three years' further engineering experience. He founded the firm of J. W. Brooke & Company, Limited, in 1874, since which time it has been a continually expanding one, so that now "Brooke" motors in connection with marine work are known throughout the world. Mr. Brooke was one of the very early members of the Royal Automobile Club and one of the founding members of the British Motor Boat Club. He was also a member of the Institution of Mechanical Engineers. On Mr. Mawdsley Brooke, who has been managing director of the business for several years, will now devolve the headship of the firm, but he has the assistance of his eldest son, Mr. J. M. Brooke, who, after having completed his engineering training, joined the firm twelve months ago, and now becomes a director.

MR. ANEURIN WILLIAMS, the well-known ironmaster and formerly M.P. for Plymouth, North-West Durham, and the Consett Division of Durham, died at Hindhead on January 20, at the age of 65. The deceased gentleman was born at Dowlais on October 11, 1859, the second son of the late Mr. Edward Williams, C.E., of Cleveland Lodge, Middlesbrough. He received his early education privately, and then commenced what was believed would be a business career, as a junior clerk in the ironworks at Dowlais, later proceeding in a similar capacity to his father's ironworks at Middlesbrough. After a period at Cambridge the death of his father brought another change in his career, and he went back to Middlesbrough to be one of the active partners in the Linthorpe Ironworks, in 1886. He remained there until 1890, since when he had not taken any active part in the management of the concern, or even on the directorate, though he was still a shareholder in the firm, which had been turned into a limited company. Subsequently he returned to public work, and his first interest was the Labour Co-partnership movement, and then the Garden City movement. His literary ability was considerable, and from his pen came works on "Co-partnership and Profit-Sharing," "Twenty Years of Co-partnership at Guise," and an article on "Co-operative Societies" for the "Encyclopedia Britannica."

MR. H. R. SUMMERS has resigned the secretaryship of the British Engineers' Association.

The Action of Molten Brass on Nickel Steel.*

By H. M. Duncan, B.Sc.

Although the Institute of Metals deals exclusively with the non-ferrous metals, and whereas this paper is very largely concerned with nickel steel, yet it was thought that the peculiar behaviour of certain nickel steels in the presence of some of the non-ferrous alloys in the molten state justified the Paper being presented before a Branch of the Institute of Metals.

The experiments, so far as the author is aware, were not known prior to November, 1921, the date at which they were carried out. At that time, owing to the working stress on turbine blades being increased, it was found necessary to use a stronger material, and it was decided to adopt a nickel steel having the following analysis:—C, 0.25 to 0.3; Mn., 0.10 max.; S, 0.04 max.; P, 0.04 max., and Ni, 3½ to 5 per cent. The tensile properties after an annealing treatment were:—37.1 tons per sq. in. maximum stress; 26.3 tons per sq. in. yield point; 21.3 tons limit of proportionality; and 29 per cent. elongation on 2 in.

Rectangular strips 0.21 in. thick and of varying widths gave from 80 to 100 bends through an angle of 90 deg. in both directions, the free length of the strip being 4 in. This test was done in an attempt to find initial cracks in the steel. These results are quite satisfactory, and would seem to indicate that the material was quite sound and in a good mechanical condition. The strips were next rolled into blade form at Heaton Works in the usual way, both hot and cold rollings being given with an annealing after each cold rolling. The blades were then cut to length and brazed to distance pieces.

Process of Brazing.

The blade and distance piece are riveted together and lowered into a crucible containing molten 70/30 brass with a floating layer of molten borax on top, having a depth a little greater than the height of the distance piece, the crucible being maintained during the operation at a temperature of 1,000 to 1,050 deg. C. The blade and distance piece are immersed in the layer of molten borax for 15 secs., and are then lowered into the molten brass below and kept there for one minute, when they are raised to the layer of borax and held there for a further 15 secs., afterwards being withdrawn and allowed to cool down in the air.

It was observed that when steel in blade form containing 3.5 per cent. nickel and having a tensile strength of 37 to 42 tons per sq. in. was treated in this manner, cracks were formed in the blade and brass had penetrated these cracks in some cases to a depth of ¼ in. A great number of nickel steel blades were submitted to this treatment, and about 50 per cent. cracked. It was thought at first that the cracks were already in the blade before immersing in the molten brass, but all attempts to discover these cracks before immersion were unsuccessful.

Low Percentage Nickel Steel Free from Cracking.

Nickel steel bars of rectangular section, containing 5 per cent. of nickel, were then obtained from another firm, and after rolling into blades, immersed in molten brass, with the result that every blade so treated cracked in several places and contained brass in the fractures. Experiments carried out with 5 per cent. nickel steel in the form of rectangular bars with square edges, also cracked when immersed in molten brass, and it was noticed that the brass had only penetrated at the four corners; the same result was obtained when the outer surfaces of the bars were milled off to a depth of ⅛ in., whereas the bars of full width but with the edges rounded off did not crack when immersed in molten brass. As the percentage of failures was much greater in nickel steel containing 5 per cent. of nickel, it was thought that the percentage of nickel might be the cause of the cracking, and so blades were made containing 1, 2 and 3 per cent. of nickel, and in no case did any of them crack on immersion in molten brass. Blades made from mild steel of 30 to 35 tons tensile strength, but containing no nickel, also did not crack when immersed in molten brass, thus indicating that the cracking was in some way influenced by the presence of nickel in the steel; or so it was thought at the time.

Unequal Stresses Cause Cracks.

Dr. Hatfield, of the Brown Firth Research Laboratory, Sheffield, with whom this matter was discussed, carried out a series of experiments at Sheffield, and came to the conclusion that steel in the presence of molten brass is brittle when stressed. Samples of 5 per cent. nickel steel sheet were heated in contact with borax and brass to a temperature of 1,000 to 1,050 deg. C., and one sample bent with the result that it snapped off; another sample was allowed to go cold and bent 180 deg. with no sign of fracture. The third sample was bent at the same temperature as sample 1, but with no brass or borax present, and went 180 deg. without cracking. Similar tests have been performed on mild steel sheet with the same result. Samples were tested in the same manner with borax alone, and the results were quite satisfactory, from which it would appear that when a blade is immersed in molten brass the material is stressed, due to the unequal expansion of the outside and inside, and in the presence of molten brass cracks are formed. In all the experiments it has never been found that this treatment produces cracks in mild steel blades containing no nickel, although a great number of blades have been tested.

Heating Data and Foreign Materials.

It was thought that by slowly raising nickel steel blades to a red heat before immersion cracking would be avoided, and so several blades were heated in a crucible to a full red heat (about 800 deg. C.) and then immersed in molten brass as rapidly as possible, but in several instances the blades cracked and contained brass in the fractures. Five per cent. nickel steel blades were next immersed in molten borax at a temperature of 1,050 deg. C., and in no case was a blade cracked. Immersion in molten lead at 1,050 deg. C. gave the same result, but molten copper produced cracks with copper in the fractures. It was found in one instance that a temperature of 1,000 deg. C. did not produce cracks, but this was regarded as abnormal.

It was then suggested by Dr. Hatfield that a deep layer of molten borax should be kept on top of the molten brass, and that the blades should be immersed in the borax till they attained the temperature of the borax, and then lowered into the molten brass; this was done, and none of the blades were cracked. The time of immersion was about two minutes. It would appear, however, that the cracking is due to the action of molten brass on nickel steel containing from 3.5 to 5 per cent. nickel when in a stressed condition

Several teeth, both broken and unbroken, from a nickel steel pinion containing 3.5 per cent. nickel (some of the teeth of which had broken in service), were submitted to this brazing test, and in two or three cases the teeth cracked and brass penetrated the cracks.

Pieces of 25 and 36 per cent. nickel steel did not crack on being submitted to this brazing test, which is interesting inasmuch as it indicates that steels containing high percentages of nickel, as well as low, are not susceptible to brass penetration when stressed in this manner.

Results Reversed.

It will probably be agreed that the above conclusions are substantial, especially when it is understood that the material was supplied by two of the leading firms in Sheffield. However, the author's firm were so satisfied that they decided not to use nickel steel for turbine blades.

* Extract from a Paper read before the North-East Coast Local Section of the Institute of Metals, Mr. F. Adam presiding.

When it was decided to publish the results of these experiments, it was considered that it would add to the value of the paper if the response of several different kinds of steel to various molten non-ferrous metals was examined, and, with this end in view, samples of steels were obtained from Messrs. J. H. Andrew & Company, Limited, of Sheffield, and Messrs. Beardmore, of Glasgow, and in due course these were submitted to the action of molten 70/30 brass, in exactly the same way as before.

They were then bent to and fro until they fractured, and in no single case was there any sign of brass in the fracture, not even with the 5 per cent. nickel steel. This result was so unexpected, that samples of the original 5 per cent. nickel steel were tested in the same way as a check, and the fractures all contained brass.

Many others have probably had the same experience, and it illustrates very well the great difficulties which one encounters in the solving of problems which occur in ordinary works practice. The problem has not yet been solved, and it may be that the solution will explain the mysterious failures of 3½ to 5 per cent. nickel steel pinions, which have occurred in merchant vessels in recent years.

In conclusion, the author apologises for submitting a problem which has not been solved, but there was so great a delay in receiving the further samples, that it was only recently it was discovered that the new 5 per cent. nickel steel would not crack when immersed in molten 70/30 brass.

DISCUSSION.

An interesting discussion followed, which is covered by the author's reply.

Mr. Duncan, in reply to the Chairman, said that the brazing was not to prevent rusting but rather to ensure that the blades and distance pieces were tightly joined together and would not pull apart under stress. The brazing, therefore, was simply to get a firm junction between the two. They adopted the use of steel solely on account of the increased stress on the blades. He agreed that in some cases the cracks on the edges of the blades were due to shearing. In one case the outer edges of the bars were milled off, but this had not the slightest effect.

In answer to Mr. Long's question as to whether the cracks in the blades had in some parts filled with brass, whilst in others they had not, he said that the blades were fixed into a vice and bent backwards and forwards. One blade might be bent many times without breaking, whilst another blade would break almost at once. When it broke one could tell that there had been brass in the fracture but, as this did not occur every time the blades were immersed in the brass, it rather pointed to the fact that there must be some cause either in the composition or in the surface of the material.

He thanked Dr. Hutton, Director of Research of the Non-Ferrous Metals Research Association, for his kind remarks. He explained that there was no decarbonisation and that the penetration of the brass was intercrystalline.

Replying to Mr. Hamilton, the lecturer said that they had not examined the cobalt-content because, at that time, they had thought that the research was completed. It was only last week that they had found that the present day 5 per cent. nickel steel did not crack when immersed in molten brass. He was very pleased that Mr. Hamilton had mentioned cobalt, and they certainly would ascertain whether it affected the case.

In answer to Mr. Thew's question as to whether the steels which they had used in 1921 gave the same results to-day, he said that he had not used them after finding that the new steels did not crack, but hoped to get some samples of their steel of to-day, and he hoped that they would not give the same results as in 1921.

In reply to Mr. Wragg, the lecturer said the bending test was not a Sankey test. They simply prepared a bar, fixed one end into a vice, and bent it backwards and forwards, no mention being made of the amount of energy absorbed. They were not looking for that when, in the early days, they were testing to find the quality of the metal. With regard to the steel of to-day, they had not had the samples long and as yet had not been able to determine the properties of the new 5 per cent. nickel steel, but he thought it was probable that it would give 200 bends.

Mr. Wragg had suggested that cold work would cause cracking, but, as soon as they found that the blades were cracking, they took good care to anneal them; which, however, had not the slightest effect. The micro-structures of the metals were examined, and in no case could they say that the cracks were due to overheating.

He agreed with Mr. Wragg about putting a high polish on the steel. Another method was to dip the piece of metal into a colloidal mixture of oil and iron filings, when the iron filings would gather round the crack.

Tin in Cast Iron.

According to a research conducted in the United States by C. E. William, C. E. Simms and C. A. Newhall, which was given before the Electro-Chemical Society, tin has not a marked effect on cast iron.

Chemical analyses showed a decrease in graphitic carbon as the tin content increased, and microscopic examination gave evidence that less than 1 per cent. of tin has no effect upon the size and shape of the graphite. These effects of tin are in direct proportion to the amount present, and roughly 1 per cent. of tin will reduce the strength of grey iron 15 per cent. The effect on hardness and graphitic carbon will not be over 10 per cent. When the tin content is 2 per cent. or more, the molten iron appears dirty, does not fill the mould well, and the resulting castings are found to be rough and porous.

It seems, therefore, that tin plate scrap or old tin cans can be used in the production of synthetic grey iron for the ordinary grade of castings provided the tin content of the product can be kept to 1 per cent. or less. If the scrap contains more than 1 per cent. of tin, it should be mixed with enough scrap free from tin to bring the average tin content to about this figure.

Book Review.

Cobalt Ores. By Edward Halse, A.R.S.M. Prepared under the direction of the Mineral Resources Committee of the Imperial Institute and published by Mr. John Murray, Albemarle Street, London, W. Price 3s. 6d. net.

This book is one of the Imperial Institute monographs on mineral resources, with special reference to the British Empire. For our readers, the first eighteen pages, which include the uses of cobalt in both ferrous and non-ferrous metallurgy, are the most interesting. For steels cobalt has established as a useful element in connection with the magnetic properties. In making a reference to this on page 14 the author has not made it quite clear that this alloy is considered commercially as a special steel. This impression has more colour lent to it by the opening of the next paragraph but one, which opens with the expression: "As a steel alloying element." In this particular paragraph it is stated that a 4 per cent. cobalt high speed tool will cut manganese steel. Surely, some reference to speed of working should be given, for we are not at all sure that the cobalt *per se* is the governing element. However, these are by the way and apart from the object of work under review. Its object is to tell readers the distribution of the ore throughout the world, its characteristics and uses. Sufficient information is given as to its established and prospective uses to enable those interested to obtain additional information by reference to the bibliography which is included as an appendix.

Pulverised Coal in America.—That pulverised coal is being extensively used as a fuel in the United States is shown by the fact that the total annual consumption is now about 12,000,000 tons, and is growing steadily.

Patterns for Bulkhead Pieces.

By James Edgar.

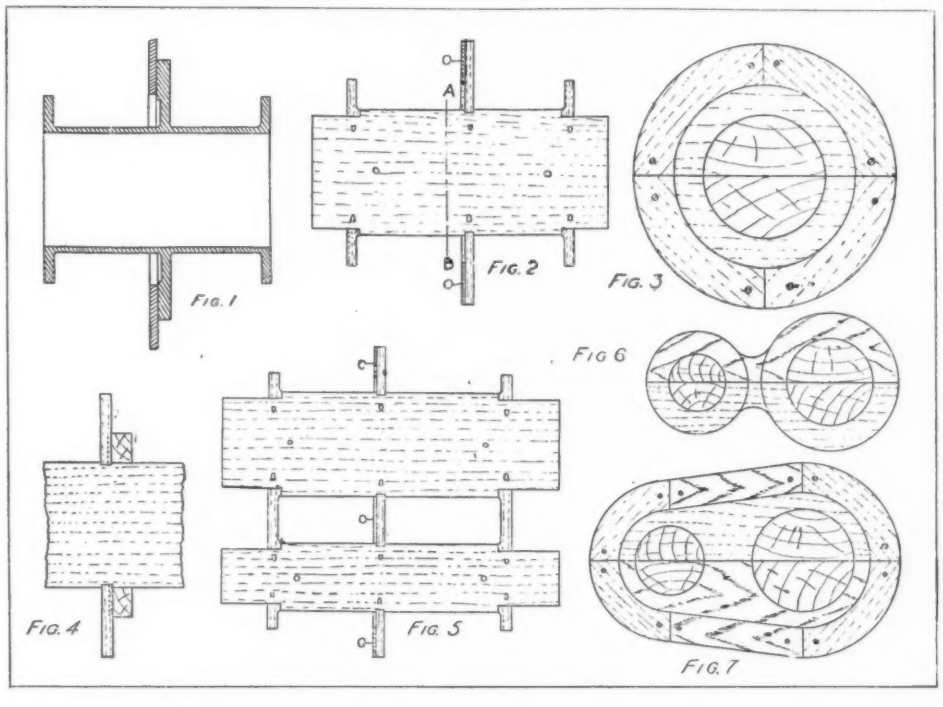
It not infrequently happens when a patternmaker is sent to a ship to make a sketch or a template for a required pipe casting that he finds the pipe has to go through a bulkhead. In the case of new vessels a finished drawing may be supplied to the pattern shop, but even then it is often stipulated that the pattern be tried to place. Arrived at the shop, it is generally found that a hole has been cut in the bulkhead which is more likely to be too large than too small, and it may be necessary to increase the size of the bulkhead flange.

When fitting a new range of pipes in an old vessel it is usual to leave much to the patternmaker, with the stipulation perhaps that some old castings must be used in. It is not uncommon, therefore, to find pipes of different metal thicknesses in the same line, and even of different diameters. The difficulty of joining flanges with the bolt circles of different diameters is most easily surmounted by fitting special pipes between them, making the flanges different to facilitate erection. The closing piece—the last pipe to complete a range—should never be a bulkhead piece, because it is obviously difficult and often impossible to fix such a pipe unless there is plenty of room to push it through the bulkhead or the pipes have not been finally erected and can be pushed to one side.

As to metal thickness, it is quite a common practice when making one or two new pipes for an old range to err on the safe side, and design the new pipes the same thickness as the thickest old pipe. It is more reasonable practice to obtain some particulars as to the pressure which they will have to withstand, and, by reference to an engineer's pocket-book, obtain the correct thickness necessary.

With regard to bulkhead pieces in particular, Fig. 1 illustrates a single bulkhead-piece in position, the bolts and nuts not being shown. In the two examples given in this article the large bulkhead flanges are square both with the pattern joint and centre line, which simplifies the construction of the pattern because the cylinder can be grooved to receive the flange. As often as not the flange has to be angled, which is the reason for the drawing-office stipulating that it must be tried to place. When no drawing is supplied it is for the patternmaker to make a rough sketch in the first place and alter the flange when finally trying it in position. When the patternmaker has to give instructions as to the size of hole to be cut in the bulkhead he will be well advised to stipulate that it be ½-in. larger than the flange. The diameter of the bulkhead flange depends upon the diameter of the clearance-hole, but it is safe to regard the clearance as though it were the outer diameter of a pipe, and make the size of the flange in accordance. At Fig. 1 the bulkhead flange is shown thicker than the pipe metal, but in most cases there need be no difference.

Fig. 2 is a joint view of a typical bulkhead-piece pattern. There is nothing difficult about it, but a facing must be fastened to the bulkhead flange. When it is possible, this facing is made loose in segments, and either wired on, as shown at Fig. 2, or screwed on, as shown in the sectional view, through AB, Fig. 3. This practice has to be departed from when the facing is almost as thick as the flange. The facing, it may be said here, should be sufficiently thick that when it has been machined there will still be a facing of ⅛-in. or 3-16-in. left. When it is not possible to draw the facing into the flange the recess between the body and the facing is printed as illustrated by Fig. 4, and a suitable corebox made.



There is no material difference in designing a double bulkhead-piece from a single bulkhead-piece. When two pipes pass through a bulkhead close together it is usually more convenient to join them as one casting, and to cut one large hole through the bulkhead. Fig. 5 shows a joint view of a double-piece pattern, while Fig. 6 is an end view, and shows the method usually adopted of recessing between the flanges, and thus leaving what is virtually a rib. Fig. 7 is a section from which the shape of the flange will be observed.

Bulkhead pieces are occasionally made so short as to be awkward to fit in position. In shops where they are a regular job it is customary to alter old patterns over and over again. It is always the endeavour to make that part of a pipe range which goes through a bulkhead as simple as possible.

British Tenders in Canada.—A cable from Toronto states that the action of the City Council last year in refusing to accept the lowest tender made by a British company for a large order for cast-iron water pipes and awarding the contract at a compromise price to a local firm whose original quotation was higher, was recently discussed at a meeting of the Toronto Board of Trade. The meeting ultimately passed a resolution condemning the City Council's action and declaring it detrimental to the City's prestige and to the City's credit at home and abroad.

XUM

Institute of British Foundrymen.

SHEFFIELD BRANCH.

Discussion on Mr. F. H. Hurren's Paper on the Influence of Casting Temperature of Aluminium Alloys.*

The CHAIRMAN (Mr. J. Shaw) said they had had a very interesting Paper. It was practically the first non-ferrous Paper that they, as a branch of the Institute of British Foundrymen, had had. When they made inquiries from the members as to the branch of the foundry trade they were connected with, they found that they had quite a number who were connected with the non-ferrous trade; hence that Paper.

DR. PERCY LONGMUIR, in opening the discussion, said that about 20 years ago he had carried out a certain amount of work. Unlike Mr. Hurren, he found that the intermediate, the fair casting heat, always gave the best results. That was, of course, not on aluminium alloy, but on the commercial aluminium of those days. He had been intensely interested in the ageing effect on these aluminium alloys, because, at the time he was speaking of, working on those metals, the only equalising effect that he got was on lead. Of course, the maximum stress on lead was indefinite, and one had to go on the elongation. He found that casting too hot gave a low elongation; casting from the same crucible at a fair heat gave a very fair elongation; while casting too low—by which he meant just low enough to give a sound casting—again gave a low elongation. Now, companion bars, put away for three months and tested, gave equal elongations. The ageing effect of these aluminium alloys was therefore one of very great interest, and he hoped that Mr. Hurren would follow out his work in that direction.

All his working life he had objected to what he called the stewing of any metal, and they had had good proof of that that night. He himself had found, particularly with the copper-zinc alloys chiefly, stewing to be intensely bad. Apart from the volatilisation losses of zinc, involving a change in composition, there was a decidedly bad effect, which, as the lecturer had shown, did not necessarily show in tensile, but did show in some form of a brittleness test suddenly applied.

DR. LONGMUIR added that he would like to support what Mr. Hurren had said: that the casting temperature, not only of the particular alloys that he had investigated, but of all alloys, must necessarily vary with the type of casting. In his own experiments with Admiralty gun metals, with Muntz metals, and so on, he found that many American text-books were quoting him as stating that his own fair heats were the correct heats for all types of casting. But those temperatures only represented, and could only represent, the most suitable conditions for that particular type of casting. If one had, say, a 3-ft. cube and then a 3-ft. plate by ¼ in. thick, necessarily the temperatures must vary.

PROFESSOR C. H. DESCH said, like Dr. Longmuir, he had always urged that stewing was a most pernicious practice, whether carried out intentionally or just as the result of careless working. To deal for a moment with another alloy, in which there was no question of volatilisation, namely, gun-metal, he had found several cases in which castings of gun-metal, prepared at roughly the same temperature, differed from one another to the extent of one giving double the elongation of the other, the better result being obtained simply by the avoiding of stewing, by pouring the metal directly the temperature was reached.

Why "Y" is Difficult to Cast.

He noticed that Mr. Hurren had some difficulty with the alloy "Y," which he believed had been the experience of very many users. It happened to be a very tricky alloy to use, and very few people, he thought, had succeeded in reproducing the results from it that had been obtained at the National Physical Laboratory, where the staff had been working on it for a long time and had acquired special skill. The order of Mr. Hurren's tests came out slightly differently, in the case of the "Y" alloy, from the order of the other alloys, and this suggested that casting at so low a temperature as 625 deg. C. did not really give the "Y" alloy a real chance, because it contained nickel. Now the nickel-aluminium compound that formed had a high melting point, a high temperature at which it fell out of solution. He had not the diagram by him at the moment, but he thought that at 625 deg. C. there would actually be crystals in that alloy out of solution and in suspension, which would, of course, prevent one from getting a very good casting.

The ageing effect was of extraordinary interest—the ageing effect that was first discovered in duralumin, and was now known to be characteristic of so many alloys. That, of course, had now been quite satisfactorily explained. The work of Dr. Rosenhain and his collaborators had shown that they had there the magnesium and silicon concerned, and that it was due to the falling out of the older microscopic particles from solution and then the gathering together of those particles to form larger masses. Following up those changes, they could, as a matter of fact, account for the whole of the ageing. He should like to ask Mr. Hurren whether he made any experiments on artificial ageing. The periods of 85 days and so on were, of course, long, and made the experiments very tedious, but, as most of the alloys could be aged artificially in boiling water, or at temperatures somewhat higher, it might be of interest to know whether he obtained the increase there. The increase in resistance to repeated impact by ageing was very extraordinary. He did not remember seeing such large differences before. He took it that Mr. Hurren had not been able to follow out microscopically the difference that took place on ageing. It was an extraordinarily difficult thing and required high power work, but it would be interesting to know whether there was any visible change, giving such considerable increase in resistance to shock as was shown by those tests.

In regard to the general results of the effect of temperature, he took it that Mr. Hurren concluded that the best results were obtained by casting at the lowest really fair temperature. He thought that would be a quite general conclusion from the results if they ruled out those 625 deg. C. tests on the "Y" alloy, which, he thought, were probably not fair tests for the alloy at all.

MR. E. H. HILL said the lecturer had spent a very considerable time in making tests on what they might term comparatively hard alloys, and the influence of the casting temperature on the tensile strength. One point which seemed to him worth consideration was, what would be the effect of casting temperature on the softer alloys, with regard to the elongation? The elongation shown by the tests which had been exhibited that night were all very small. He thought the greatest which occurred in any sample was about 7 per cent., which, for an aluminium alloy, to his mind, was very low. The ductility of aluminium was a very important characteristic of the metal, and he should be glad of some information regarding casting temperatures and ductility.

MR. HURREN, in reply to the discussion, said he was very pleased indeed to see Dr. Longmuir there that night, as he would like to say that it was that gentleman's pioneer work, published as a Carnegie Memoir, which first started him on this idea of the casting temperature for aluminium alloys. Dr. Longmuir's work, when he read it, struck him as being of intense value, and one which might be extended to his own particular class of material. He was also glad to see that Dr. Longmuir was in agreement with him that stewing, or overheating, of any material was most

* This Paper appeared in our last issue.

objectionable. So far as variation of casting temperature for the type of casting was concerned, he might say that in their own work they cast some articles—crank cases he had in mind—always at 720 deg. C. A bearing gauge, which had a very much thicker section, they cast as nearly as possible to 630 deg. C., and they had tried to standardise different casting temperatures for different jobs. In many ways they were fortunate, as much of their work was repetition work, and once they had determined the best casting temperature for a certain job they could very often carry on for weeks at a time. If the work was what was known in foundry parlance as jobbing work they would either have to spend a considerable time in experiments or to take risks.

Dr. Desch had emphasised the difficulties which had been found with "Y" alloy, and at present he (the speaker) must confess that they had not been able entirely to overcome those difficulties. There seemed to be a particular range of temperature at which good castings could be obtained with "Y" alloy, and outside that range there was nothing but failure. The commercial difficulty with "Y" alloy also lay in the fact that in the as-cast condition only poor results were obtained, and that the castings must be heat-treated. This introduced a very serious difficulty into a works turning out a fairly heavy tonnage or a large number of articles. He was of opinion that Dr. Desch had pointed out the cause of the difficulty of casting "Y" alloy at comparatively low temperatures, in the fact of the nickel-aluminium crystals remaining in suspension rather than in solution. They had noticed time and again that the metal was apparently liquid one second, and went pasty and had to be scraped out of the pot within a very few seconds after.

Natural Ageing.

He had made no experiments on artificial ageing at present, as he wished to determine the effect of natural ageing in view of the fact, as he stated in the paper, that they made castings one month which were in use six or sometimes eight months later. The microscopical examination of sections of aluminium had been followed out to a certain extent, but there were so many manipulative difficulties in the way that he did not feel capable of placing micrographs before such an assembly.

Dr. Desch had also emphasised the necessity of casting at the lowest fair temperature. In regard to that, he could only repeat what he had already said respecting Dr. Longmuir's remarks.

Mr. Hill inquired as to the effect on softer alloys than those he had shown that evening, and also remarked that the elongations appeared to be small. The alloys which he had shown were those which were commonly specified for automobile work, and, although the elongations appeared small, it was a matter of extreme difficulty to get an aluminium-copper-zinc alloy, or an aluminium-copper alloy, to give an elongation much over 6 or 7 per cent. They had had extreme instances where they had had 14½ tons tensile and 12 per cent. elongation, but how they did it he did not know now. The reason, therefore, why he had not dealt with the softer alloys was that at present they had no commercial value in an automobile works. His tests had all been taken during the ordinary course of production: they were not specially dressed up for the occasion, but were simply selected from tests which had been made at various periods since the early part of 1916.

Mr. Shaw, the Institute of British Foundrymen's Branch-President, asked him to give a non-ferrous paper, and, as he had known that gentleman for a number of years and always had a great respect for him, and as Mr. Shaw was in the unique position of having been president of two separate branches of the Institution of British Foundrymen, he gladly consented, but when Mr. Shaw told him that he had also arranged for that meeting to be a joint one with the Institute of Metals he wished he had not been quite so rash in promising. Frankly, he had been rather afraid of the Institute of Metals. He had always had an idea that nothing but pure physical chemistry was acceptable to them.

THE CHAIRMAN said he thought they would all agree with him that Mr. Hurren had not very much need to be afraid of what he had put forward. He had put before them a certain amount of original work, done under shop conditions. When he told them that Mr. Hurren had in one of his workshops (he did not know whether he had at this moment) over 100 moulders working on aluminium, they would have some idea of the scope and size of the shops and, as a very great deal of the work was on moulding machines and was being turned out on mass-production lines, certainly Mr. Hurren had the opportunity of gauging the casting temperatures and the other things to make the success of it that he had. His paper might not be one on pure science, but it described conditions that he had obtained in actual works practice, and as such it ought to be beneficial to those who were in a like line. The temperatures that he had given were such as the ordinary man, with the use of an ordinary pyrometer, could obtain.

Vote of Thanks.

MR. J. R. HYDE, in proposing a vote of thanks to Mr. Hurren, said the paper showed that all the difficulties were not in steel foundries. He thought they were a great deal indebted to the people who tackled the problem of aluminium alloys, and so saved them the trouble of having the difficulties of the automobile industry brought to Sheffield. They had quite enough troubles of their own. But there was another point about it—that unless the aluminium castings were produced successfully there would be no great demand for Sheffield's steel or other manufactures to build up into the complete motor-car. They must all work together, and he was sure that an exchange of knowledge in this manner was highly beneficial.

ENGINEER-COMMANDER JACKSON seconded. He said it was always a pleasure to hear the results of a man's experience. He knew very well that that kind of thing was not done for nothing. There must have been a fair amount of work put into the paper, and they were under a debt of gratitude to Mr. Hurren for giving it. He had not had much experience himself with aluminium alloys. In the small quantity that he had melted, he had always found a sort of red oxide come on the top, and had wondered what it was and taken it off. He had found that when the red did not come, that was about the temperature to cast at.

MR. E. H. HILL, in supporting, expressed the thanks of the Institute of Metals to the Institute of British Foundrymen for their invitation to attend that meeting. The Sheffield section of the Institute was very much interested in non-ferrous alloys, and its members were always pleased to see members of the Foundrymen at their meetings. He should like to express his appreciation of Mr. Hurren's practical work. He had had some experience of Rover cars over a period of twenty years, and the aluminium casting in them had always been particularly good.

The resolution was carried unanimously.

MR. HURREN, in response, said he should like to tell Mr. Hyde that the steel-casting man had not all the troubles in the world. He might think in Sheffield that he had got a monopoly of them, but, even if that were so at some time or another, he thought some of them had now moved down into the Midlands. Although there might be a lot of trouble with steel, there was also a considerable amount with aluminium, and, he thought, as a matter of fact, there was considerable trouble with all foundry work.

The Bourcoud Process in America.—In reference to the statement in last week's issue to the effect that the Ford Motor Company will erect a plant at River Rouge, Mich., for the production of steel direct from the ore according to the Bourcoud process, the Ford Company has issued a statement that some investigations on the direct reduction of iron ore are being made which will require the demonstration of some of the problems to a limited extent. The Company is not confining itself to any specific theories or methods, but will follow leads which seem to have promise.

German Foundrymen's Association.

ANNUAL REPORT.

During the year under review our industry, like others, has suffered under the severe economic depression prevailing in the country as the result of the Versailles treaty and the occupation of the Ruhr.

Despite these obstacles, however, we are happy to report a considerable increase in the activities of the Verein Deutscher Giessereifachleute (German Foundrymen's Association) during the past year. Our membership has also shown a most satisfactory increase from 900 to 1,100, having thus exceeded the thousand mark. A great deal of profitable work was also done by the various branches.

The work undertaken by the Moulding Sand Sub-Committee, on the investigation of moulding sands and the German moulding sand deposits, has reached the conclusion of the first stage, and, in conjunction with the Union of German Foundries, we have published two maps. Each map is prefaced by a short introduction, giving the more important results of the chemical examination, and a sketch showing the distribution of the sand in the various geological formations of the country. An alphabetical name index gives information regarding railway connections, sources of supply, and sphere of use of the various types of sands.

The work of the Sub-Committee on Cupola Bricks, presided over by Engineer Gilles, could not, unfortunately, be proceeded with owing to the occupation of the Ruhr, the German Union of Refractory Material Manufacturers (without whose co-operation a successful issue was apparently impossible) having requested that the work be suspended owing to the difficulties involved. Meantime, however, the Sub-Committee had decided thoroughly to test the durability and practical application of various types of refractory linings. At a meeting of the eastern group of the German Foundrymen's Association, a number of firms had declared their readiness to carry out the investigations at their works.

The tests were to be carried out as follows: Three of the best-known refractories in the Berlin district, the silica and alumina contents of which vary greatly, were to be tested in a similar manner in the various works. To ensure uniformity of method, etc., it was decided that the lining should be carried out by the representative from each of the firms supplying the material.

A programme was drawn up and an inquiry form prepared with a view to obtaining all the data required to enable the necessary conclusions to be arrived at.

Only one firm, Schwartzkopff, have suggested a practical method of carrying out the investigations, and upon this Herr Gilles submitted a full report to the Main Technical Sub-Committee.

At the suggestion of Prof. Kleinvogel, the Association took up the question of the possibilities of ferro-concrete for use as pattern plates in the moulding shop. This work has been taken up by a number of foundries at our request.

Although it is not possible at present to decide definitely whether ferro-concrete can be used for the purpose specified, as the experiments have not been completed yet, the results obtained up to now show that there is not much likelihood of ferro-concrete being used as a substitute for plaster of paris for pattern plates. Nevertheless, it appears possible that ferro-concrete may find some other field of application in foundry work. For this reason the German Foundrymen's Association will continue experimenting with this material in the future with a view to its practical application in foundry work.

Since its last general meeting on September 6, 1922, the Main Technical Sub-Committee has held a meeting at Homburg, while they held a further meeting on the opening day. Both meetings were preceded by a business meeting, at which technical Papers were read. In addition to the work on moulding sands and refractories, as already mentioned, other work of an important character is in hand. Among other subjects dealt with may be mentioned: Investigations on the relation between shrinkage and furnace charge; strength tests on grey cast iron; improvements in the welding process for grey cast iron and cast steel; and the testing of semi-steel.

With a view to centralising the work of standardisation in foundry practice, and thus speeding up the work, a sub-committee for foundry standards was formed (in brief, the Gina), with headquarters at Düsseldorf. This sub-committee is controlled by the Union of German Iron Foundries.

During the past year the German Foundrymen's Association has again interested itself in the needs of the high and intermediate schools. In addition to making grants of money, the council of Association was also able to help a number of needy institutions by providing fittings and laboratory equipment, besides affording valuable assistance in the shape of providing the means of instruction in schools where foundry practice is taught. Valuable aid and laboratory equipment were also placed at the disposal of the Geological Survey in Berlin in connection with the investigation into moulding sands which the Survey undertook at the request of the Association.

The Association has also done valuable work in connection with the careful and expert training of the apprentice foundryman. Herr Gilles, member of the Council, has, at the request of the Association, done active work in this connection, and at the Brandenburg group of the Association he read a paper giving the results of this long and tedious work.

Together with the German Commission of Technical Education, the Association is doing everything possible to recommend the systematic and practical training of foundrymen, and to adopt some system of practical training for students of foundry practice, much in the same way as has been done for the works students in mechanical engineering.

The Association have also taken a share in the work of the German Union of Technical Societies, in so far, of course, as its own branch of industry is concerned, and has continued to maintain friendly relations with kindred societies.

The foregoing report merely gives a brief review of the manifold problems and the wide sphere of activity of the Association.

ABSTRACTS OF PAPERS PRESENTED.

Reflections Regarding a New Theory of the Acid Converter Process.

BY CARL P. LAVAL, Foundry Engineer.

The new theory of the acid converter process is the result of observations on many ten thousands of heats—the experience of twenty years in small Bessemer converter work.

The author maintains that, during the whole of the heat, iron alone is burnt, exclusively and directly, and that the ferrous and ferric oxide give off their oxygen, which combines with manganese silicon, and carbon within the bath. Regarding the process of the charge from this standpoint, it will be found that, when the blast is turned on, a reddish flame appears after a short time, with the development of a thick brown smoke. This is apparently the manganese burning. It cannot be supposed that the oxygen of the air, even after passing the blower, singles out the ½ per cent. of manganese in the bath and burns round about it for from three to five minutes. Again, at the end of the charge, the spectroscope still exhibits manganese lines, so that not all of that material can be burnt up at the outset. Thirdly, there is a certain similarity between the initial flame and the final flame of a completely melted charge.

Where the bath is saturated with ferric oxide, the combustion of the silicon begins with an audible motion. It is frequently impossible to confirm the existence of the first, so-called manganese flame, *viz.*, where the liquid iron leaves the cupola saturated with Fe_2O_3 to such an extent that the

silicon commences to burn at once. The heat is then considerably increased, so much so, in fact, that the high-percentage iron carbides are split up, and the well-known characteristic eruption occurs, due to the presence of the carbon monoxide or dioxide. Gases are required in order to call forth these eruptions, and these gases must be present within the bath and must force out the liquid resting on them. Silicon does not generate gas, but only carbon. The violent sparking which takes place at this stage is the sparking of the iron alone.

To the extent that the silicon burns, the converting period passes over to the refining period, in which the residue of the carbon is burnt up. A thin, white flame darting up and down is the distinguishing feature here. There is practically no sparking at all, only small round particles consisting principally of slag or iron which is already burnt, these particles being ejected and bursting into smaller particles. The streams of sparks of the burnt iron cannot be seen.

With a loud gurgling sound, the ferric oxide removes the last of the carbides, which, becoming ignited inside the bath, violently eject the iron resting on them.

Interrupted at this moment, the charge requires the smallest quantity of added matter, even though about 30 per cent. of the manganese and silicon added to the charge is required for the reduction of the iron oxide liberated in the bath.

The fact that it is the dissolved iron oxide purely and simply that is responsible for the decomposition, conversion and burning of the fuel materials becomes pretty evident when we consider the behaviour of an over-blown charge. If liquid iron from the cupola be added to such a charge, the carbide is at once decomposed, and burns a long white flame issuing from the mouth of the converter. If the quantity added is too great, and the bath is stirred, an explosion takes place, and a much more violent one than occurs during the heat. An explosion of this kind has frequently been sufficiently violent to blow out the whole of the contents of the converter, injuring men and damaging machines, cranes and the building.

It is very difficult, of course, with the limited experimental plant available in works, to carry out the experiments necessary to prove the foregoing assertions.

The author hopes that a great number are convinced of the possibility of his statements, and that it may be possible for scientists to adduce conclusive proof.

Testing of German Moulding Sands.

By Dr. J. Behr.

The author in this Paper reviewed the methods used for testing moulding sands. The real object of a test is not to decide whether a certain sand can be used for a number of different purposes, but to enable the practical man to compare the characteristic features of a specific moulding sand with those of a new sand, so as to be able to determine the limits of usefulness of the latter. Refractoriness, permeability to air, and great bonding power are the three characteristics of a moulding sand, and the writer gave examples showing how these properties could be correctly evaluated by comparing the figures for grain size, hygroscopicity, resistance to gas, permeability, water capacity, etc. The charts or maps drawn up by the writer show the principal German sand deposits, besides giving full information as to the possible uses of the sands and sources of supply. The geological maps shown would also enable prospecting work to be done with a view to the discovery of new moulding sands.

The Heat Balance in the Converter Process.

By A. Hermanns, Engineer.

The author dealt with the heat balances of the various converter processes, comparing the acid Bessemer process, the basic open-hearth process, and the acid process in small Bessemer converters. By means of original curves, the author showed the flow and distribution of heat in the several processes, and compared the processes numerically with each other. The high iron losses in the small Bessemer converter process led the author to refer to the fundamental design of the small converter and the side blown tuyeres. As distinct from the large-scale process, the bath is not thoroughly agitated by the blast, but the latter only exerts a slow and partial movement of the liquid iron. Owing to the length of the heat, a considerable amount of the iron is converted by the heat into iron oxide. Further, there are considerable heat losses due to radiation and to the nitrogen in the blast. These drawbacks could probably be eliminated if it were possible in the small converter process to adopt the bottom-blown method. It is, however, impossible to say from the present development of technical methods whether this method of working could be carried out on a practical scale.

Company News.

Associated Patents, Limited, Coronation Chambers, Albion Street, Leeds.—Capital £3,000. Engineers, founders, etc. Secretary: L. Whitwam.

Crispin & Company, Limited, Marshgate Lane, Stratford, London, E.C.—Capital £7,000. Refiners of copper and other metals, etc. Directors: W. W. Courtenay, C. E. Courtenay, C. W. Courtenay (chairman) and H. A. Courtenay.

F. Parramore & Sons (1924), Limited, Caledonian Foundry, Smith Street, Chapeltown, near Sheffield.—Capital £15,000 in £1 shares. Founders, engineers, etc. Directors: A. and E. Parramore.

James Keatley, Limited, 220, Hospital Street, Birmingham.—Capital £15,000 in £1 shares (5,000 6 per cent. preference). Metal manufacturers, brass founders, etc. Directors: J. Keatley, J. A. H. Keatley and J. W. G. Hill.

James H. Lamont & Company, Limited, 104, Buccleuch Street, Edinburgh.—Capital £2,350 in £1 shares, to manufacture and sell an improved joint or coupling for pipes and tubes, known as the Securex Filling, and to carry on the business of engineers, brass founders, etc.

J. Reich & Son, Limited, 2, Mosley Street, Manchester.—Capital £5,000 in £10 shares. Machinery importers and merchants, etc. Directors: Johann Reich (permanent governing director), Eric R. Reich and Albert O. Reich.

Lemet Metal Works, Limited, Lancaster Works, Legge Lane, Birmingham.—Capital £5,000 in £1 shares.

Metallurgy, Limited, 9, Dawson Street, Dublin.—Capital £5,000 in £10 shares. Directors: J. W. Griffith, F. H. Litton, G. Ghion, B. M. de Westgaver and F. Sengler.

Southern Silica, Limited.—Capital £30,000 in 96,000 preference shares of 5s. and 120,000 ordinary of 1s.

Staffordshire Stainless Iron Company, Limited.—Capital £15,000 in £1 shares. Solicitors: Churchill, Clapham & Company, 1, Broad Street Place, London, E.C.2.

W. & W. Scott, Limited, George Street, Field Lane, Batley.—Capital £1,000. Iron, aluminium and steel founders, etc. Director: F. Haigh.

W. Waistell Hird & Company (Weardale), Limited, County Bank Chambers, Marton Road, Middlesbrough.—Capital £2,000. Fluor spar, limestone and ganister miners. Directors: J. N. Ogilvie and S. Robertson.

Brew Brothers, Limited, Cranley Office, Old Brompton Road, London, S.W.—Capital £5,600 in £1 shares. Engineers.

C. E. Smith & Son, Limited, Royal Chambers, Church Street, West Hartlepool.—Capital £1,000 in £1 shares. Engineers, etc. Directors: C. E. Smith and C. F. Smith.

Edgar Allen & Company, Limited.—Interim dividend, 6d. per share, free of tax.

Elliott's Metal Company, Limited.—Interim dividends declared, less tax; 5 per cent. per annum on preference shares, and 1s. per share on ordinary.

Engineering & Scientific Research Company, Limited.—Capital £1,000. Solicitors: Redfern & Son, 38, Lincolns Inn Fields, London, W.C.

Foley Park Forge, Limited, 36, Cannon Street, Birmingham.—Capital £2,500. Permanent directors: E. Sarsons (managing director) and P. M. Browne.

Green & Faulconbridge, Limited, King's Road Buildings, Hertford Street, Coventry.—Capital £1,000 in £1 shares. Engineers, etc.

Greenwood & Batley, Limited.—Interim dividend, 2½ per cent.

John Hethertington & Sons, Limited.—Interim dividend, 3¼ per cent. actual on ordinary.

Weston Engineering & Disposals, Limited, 2A, Alexandra Road, Moss Side, Manchester.—Capital £1,000. Directors: E. Turner and A. Heron.

XUM

Trade Talk.

THE LONDONDERRY CORPORATION has accepted the tender of a French firm for cast-iron pipes.

SOUTHAM NAIL COMPANY, LIMITED, have removed to Britannia Works, 145, Conybere Street, Birmingham.

VALVIS & CASEY, iron and steel merchants, etc., have removed to 20, St. James Street, Liverpool.

THE MACHINE TOOL TRADES EXHIBITION will be held at Olympia from September 5 to September 27 of the present year.

THIRTY OF THE express goods engines, surplus war material lying at Sandycroft Factory siding, have been purchased by the L. & N.E.R.

HUGHES, BOLCKOW & COMPANY, LIMITED, of Blyth, have secured the "Monarch," of 26,000 tons, which will shortly be taken to Blyth to be broken up there.

A MEETING of the Manufacturers of Light Steel Castings was held at the Engineers' Club on Thursday of last week to examine the possibilities of forming an association.

JOHN MACDONALD & SON, LIMITED, Watt Street, Maryhill, Glasgow, have designed a new type of moulding machine for the manufacture of the new British Standard axle-blox.

THE BIRMINGHAM ALUMINIUM CASTINGS (1903) COMPANY, LIMITED, Cambridge Street Works, Birmingham, have converted one of their large bays to the manufacture of built-up aluminium tennis rackets.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED, have taken the order for the erection of a steel and concrete bridge over the Barwon River at Geelong, Victoria. The value of the order is £73,900.

MR FRANK E. THOMPSON, F.I.C., has purchased the practice of Messrs. Naish & Croft, of Alma Street, Birmingham, analytical and consulting metallurgical chemists. His laboratory is situated at 23, Lichfield Street, Walsall.

THE MYSORE GOVERNMENT STORES PURCHASE COMMITTEE is desirous of getting into touch with manufacturers of and dealers in all kinds of goods. Communications should be addressed to the Secretary, Public Offices, Bangalore.

AN ONTARIO charter has been granted to the Electro Tin Products, Limited, of Hamilton. The company is capitalised at $1,000,000 (say £237,500), and is formed for the purpose of manufacturing tin products and dealing in ores, metals, etc.

MR. T. S. GIBSON, formerly for many years London manager to the Ebbw Vale Steel, Iron & Coal Company, Limited, has joined Amstea, Limited, iron and steel merchants, etc., Bush House, Aldwych, London, W.C.2, and will become managing director.

SMITH BROS. & COMPANY (HYSON), LIMITED, valve manufacturers, Nottingham, have appointed Mr. A. E. Dickinson as their Midland representative, in succession to Mr. W. J. Whitby, who has been appointed the company's Northern representative.

TUESDAY WAS THE Diamond Jubilee of the first furnace to be put into blast at Scunthorpe, for it was on January 23, 1864, that the Trent Iron Company, Limited, now owned by John Brown & Company, Limited, Sheffield, made the first pig-iron.

LICENCES HAVE BEEN granted by the Board of Trade under the Non-Ferrous Metal Industry Act (1918) to Berry & Kennedy Metals, Limited, London; Southampton Shipping, Metal & Shingle Company, Limited, Southampton, and A. Strauss & Company, London.

FERRANTI, LIMITED, have received an order from the Tata Power Company, Limited, Bombay, for the supply of four banks of 110,000 volt power transformers. Each bank has a capacity of 30,000 kva., which is claimed to be the largest ever ordered in Great Britain.

THE GREAT NORTHERN RAILWAY (IRELAND) has placed an order with Nasmyth, Wilson & Company, Limited, Manchester, for five 4-4-2 tank locomotives and five 0-6-0 engines and tenders. The Nigerian Railways have divided orders between Sir W. G. Armstrong, Whitworth & Company, Limited, and Nasmyth, Wilson & Company, Limited.

MEMBERS OF THE Graduate Section of the North-East Coast Institution of Engineers and Shipbuilders met last week in Newcastle, under the presidency of the chairman of the section, Mr. J. C. Arthur. Mr. W. G. A. Perring, holder of the research scholarship from the Commissioners of the 1851 Exhibition, was the speaker, and his subject was the "Influence of Type of Propelling Machinery on the Running Costs of Ships."

MR. J. ELLIS, of the United Steel Companies, Limited, Workington, in a communication to the Cockermouth Board of Guardians, states that within the past fortnight one Irish Free State railway company has sent its order for rails to Continental works at 25s. 6d. per ton below the United Steel Companies' price, although the latter quoted 10s. per ton below cost. He enclosed three offers of steel, all £2 per ton below British costs, to give the Guardians some idea of what our workpeople are up against.

AN ORDER for steelwork has just been placed with Lambourne & Company, Limited, of Manchester, in connection with a new works at Cheadle. The contract consists principally of girders and roof trusses to the extent of nearly 1,000 tons, and will provide continuous employment for some months at the firm's Openshaw works. The steelwork is to be used in the erection of an engineering works, involving buildings covering many acres of land. The scheme is, of course, that of Henry Simon & Company, Limited, of Manchester, which has already been mentioned in these columns.

THE DERBYSHIRE MINING & EXPLORATION, LIMITED, which has a share capital of £50,000, divided into 200,000 shares of 5s. each, have this week offered 80,000 shares of 5s. each for subscription at par. The directors of the company are Mr. Francis Allen, J.P., 21, Duppas Hill terrace, Croydon (chairman), chairman of South Crofty, Limited; Mr. John Saxton, Birks Farm, Holmsfield, Derbyshire; and Mr. J. C. Skinner, Ashbourne, Ivy Park Road, Sheffield. The company has been formed to acquire, work and develop lead mines in the Peakland lead mining district of Derbyshire. The properties comprised in the option include the series of mines now known as the Cromford Moor Mines and the Blobber Mine, comprising the Blobber Vein and Swain's Close Vein, and the Foxholes Mine.

AT THE OPENING MEETING of the forty-third session of the Junior Institution of Engineers, held in London, the Institution Gold Medal was presented to Mr. R. C. D. Fell for his paper, "Rolling Mill Machinery"; the Institution Silver Medal to Mr. S. Austen Stignat, for his paper "Transient Phenomena arising in Transformers from Switching Operations"; the Vickers Gold medal and prize to Mr. E. C. West, for his paper, "Artificial Ice Making"; the Loughborough Local Section Silver Medal to Mr. P. L. Edmonds for his paper "Electrons and Ionisation of Gases"; the Past Secretary Dunn Medal to Mr. P. J. Waldram for his lecturette, "Ventilation and Natural Lighting of Buildings"; the Durham Bursary of £25 to Mr. F. W. Follett for his thesis "The Sanitation of Residential Districts."

THE SOUTH AUSTALIAN GOVERNMENT has accepted the tender of Sir W. G. Armstrong, Whitworth & Company, Limited, to supply 30 locomotives at a cost of £456,500, freight charges and duty inclusive. The Government of New South Wales is also placing orders in England for 50 steel cars. Nine firms tendered, and the tender of the Leeds Forge Company, Limited, at £139,000 has been accepted. Defending the proposal of the South Australian Government to spend £1,700,000 on new rolling-stock for the State railways in England, the Premier stated that the estimate of £1,700,000 was based on oversea prices. If for that rolling-stock they were to pay the prices asked in Australia, prices which on an average were 75 per cent. higher than the oversea prices, then it certainly became a serious question as to whether or not the scheme should be proceeded with on the plans submitted by the Chief Railway Commissioner. Let them consider for a moment what that increase of 75 per cent. would mean. The rolling-stock, instead of costing £1,700,000, would cost approximately £3,000,000. An item which affected the position to some extent was that a great deal of the money which was necessary in order to pay for the work would have to be raised by way of loan in England. It was much cheaper to pay for the work in London than it would be to pay for the work in Australia, because of the present exchange rates. There was no firm in South Australia which had plant capable of supplying the plant required.

Classification of Phosphoric Pig-iron.—M. G. Maurel, in an article in the "Revue de l'Industrie Minérale," deals specifically with pig-iron produced in the Longwy district, but considers his conclusions should be adopted in French practice generally. Formerly it was the custom in the district to classify by grain-size and skin-appearance, and this formed a useful guide to those who used only the products of that district. But the author is of opinion that specification by a number or by skin and grain is unsound, and considers the German method of stating the silicon content as probably the most desirable for a first rough guide. His chief reason for this view is that physical conditions at the time of pouring have a greater influence on the grain-size and skin-appearance than has the quantity of any element present, even sulphur, or the condition of the carbon contents. This latter condition, if accurately known, would be the best guide; but there are difficulties in the way, such as slowness of accurate estimation, wide differences in the content given by the quicker methods (as much as 20 per cent. of the carbon present), and the variation in form and quantity of carbon present in the same pig, owing to the conditions of pouring and cooling.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.

THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS (MANCHESTER), LIMITED.

BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The hold-up of traffic caused by the railway strike has had, naturally, a disturbing effect upon the industrial activities of the Tees-side, and business consequently has suffered to a considerable extent, although, without any serious cessation of production. Market movements in Cleveland iron have, however, been on a restricted scale. The tone of the market remains steady, with a slightly firmer tendency, notwithstanding the growing competition of Continental iron, a Tees-side works being currently reported as having bought Belgian No. 3 as low as 88s. 6d. per ton c.i.f. Scotland is also buying foundry and basic iron more freely from abroad, while the cheap foreign makes are now displacing Cleveland iron in Continental markets. Prices, so far, however, maintain their firmness, No. 1 making 101s., No. 3 G.M.B. 99s., No. 4 foundry 96s., and No. 4 forge round about 95s. per ton.

With regard to hematite some slight shading in values is reported. At last week's Tees-side market, for instance, while makers were still quoting East Coast mixed numbers at 102s. 6d., they were willing to grant concessions for suitable business. No. 1 quality was, as usual, at a premium of 1s. per ton. Similar conditions are also now in evidence in the West Cumberland and North Lancashire hematite market, but prices remain firm so far, Bessemer mixed numbers realising 115s. per ton, delivered Glasgow and Sheffield, and 120s. per ton delivered Birmingham.

MANCHESTER.—Business in the local market during the current week was restricted by the prevailing uncertainty as to the course of future developments of the labour troubles. In the circumstances it is reassuring to learn that prices are quite firmly held at from 95s. to 96s. for No. 3 Derbyshire, f.o.t., while makers state that, should the price of furnace coke be further advanced next quarter, they must obtain higher values than are now current.

THE MIDLANDS.—Notwithstanding the difficulties of the existing position, there are at present few complaints by consumers of a shortage of supplies in this area. Most of the larger foundries and ironworks hold fair stocks. The demand for foundry pig-iron has been none too good of late, but the price of forge iron remains constant, and continues to be in fair demand. Ruling prices, f.o.t. furnace, are as follow:—Derbyshire No. 3 foundry, 95s.; forge, 87s. 6d. to 90s.; Staffordshire No. 3 foundry, 92s. 6d. to 95s.; forge, 90s.; Northants. No. 3 foundry, 92s. 6d. to 93s. 6d.; forge, 86s. 6d. to 90s.

SCOTLAND.—An outstanding feature of the present position in the Scotch iron industry is the keen foreign competition in evidence, giving the impression that there is no bottom in the foreign market, although without, so far, any effect upon local prices, which are nominally unchanged at 106s. 6d. for No. 3 at furnaces, but for a round parcel less would be readily taken. The Falkirk founders are fairly busy. For No 3 Middlesbrough they are being quoted 105s. delivered Grahamston, but they can get No. 3 Continental as low as 90s. delivered.

Finished Iron.

Conditions in the manufacturing branches of the industry continue fairly steady, and values are unchanged for both marked and crown bars at £14 10s. f.o.t. for the first-named, and £12 10s. delivered for the latter respectively. There is no sign of weakening in price, and although these quotations have been in operation for some time, it is evident that the makers do not consider it advisable to disturb the business which has been fairly active of late weeks, due to the placing of good tonnages for the wagon trade. It is in the nut and bolt section that the serious Continental competition is felt. This grade of iron from abroad can be purchased quite freely at a delivered price of £8 10s., in comparison with the local makers' figure of £11 to £11 15s., and even the latter figure makers declare to be unremunerative.

Steel.

The outlook in the market for steel and its products is by no means satisfactory, business having again suffered a set-back in consequence of the prevailing labour conditions, while foreign material is coming more and more into acute competition with home manufactures. This has led to some weakening of the prices of British billets in which business was recently placed at £8 10s., while at present it is reported that the general quotation is £8 5s., while this figure is not invariably strong. There is, however, some further weakness reported in Belgian billets, and although there has been no improvement in deliveries, there are offers of 4-in. soft steel billets at £6 10s. delivered Sheffield. The price delivered into the Midlands, however, is still round £6 15s. Although business is quiet, the tone of the tinplate market keeps steady, and makers show no inclination to reduce their quotations; 24s. is still being taken by merchants who are well bought, but, of course, there is an end to this sort of thing, and it is difficult for anyone to take a "bear" view of the forward position.

Scrap.

Movements in the various markets for scrap materials during the present week have been for obvious reasons limited in scope, with fresh buying practically at a standstill and deliveries difficult to arrange. On Tees-side, however, quotations generally are unchanged, the following being current approximate prices, all delivered works:—Heavy cast iron (machinery quality), 97s. 6d.; do. (ordinary), 93s. 6d.; heavy steel turnings, 75s.; cast-iron borings, 72s. 6d.; heavy wrought-iron piling scrap, 97s. 6d.; special heavy forge scrap (plates, angles, etc.), 115s. per ton. In Lancashire, prices of cast scrap range from 85s. to 92s. 6d. per ton, delivered according to quality, and are low enough to encourage a large consumption if the ironfoundries had plenty of work in hand. The deliveries of cheap Continental pig-iron are considerably affecting the Scottish cast-iron scrap market, and inquiries are few and far between. There are, of course, certain foundries who are unable to use Continental pig-iron for their special class of work, and it is always possible to dispose of particular qualities of scrap to such consumers. Heavy machinery cast-iron scrap runs about 104s. per ton, and ordinary cast-iron scrap about 92s. 6d., with light metal and furnace firebars about 75s. per ton.

Metals.

Copper.—Values of standard copper during the past week have been stronger both at home and in America, the improvement being attributable to some increase of consumption favourable to a buying movement. The general demand, however, has increased but little and there seems little likelihood of any sustained upward trend in prices. Germany is now buying very little American copper, and the fall in the franc has made business with France somewhat difficult. Current quotations:—*Cash*: Thursday, £62 10s.: Friday, £62 7s. 6d.; Monday, £62 2s. 6d.: Tuesday, £61 12s. 6d.; Wednesday, £61 12s. 6d. *Three Months*: Thursday, £63 7s. 6d.; Friday, £63 5s.: Monday, £62 17s. 6d.; Tuesday, £62 10s.; Wednesday, £62 7s. 6d

Tin.—With only occasional intervals, the steady upward movement in values of tin continued unchecked until the week-end, when a reaction set in and a lower level was reached. The relapse was due, doubtless, to the announcement of impending heavy shipments from the East during the current month, and anticipation that the January statistics will not make a very satisfactory showing. Current quotations:—*Cash*: Thursday, £251 10s.; Friday, £250 5s.; Monday, £248 17s. 6d.; Tuesday, £248 10s.; Wednesday, £248 17s. 6d. *Three Months*: Thursday, £252 7s. 6d.; Friday, £251 10s.: Monday, £249 17s. 6d.; Tuesday, £249 10s.: Wednesday, £249 15s.

Spelter.—Business in this section of the metal markets continues active, with values again on the upgrade. Consumers in this country have purchased on a more liberal scale, and the market being already in a firm position, the price has readily responded. Reports from the Continent indicate a firm market there; the same also applies to America, where the situation has so far improved as to preclude the possibility of shipments being made to this country for the time being. Current quotations:—*Ordinary*: Thursday, £35 17s. 6d.; Friday, £35 12s. 6d.: Monday, £35 5s.; Tuesday, £35 5s.; Wednesday, £35.

Lead.—Speculative activities this week in the market for soft foreign pig have developed further strength in values, with business done on a very heavy scale. The strong feeling in the market has been emphasised by the fact that the backwardation on forward metal is now considerably smaller than it was ten days ago, when it was about 15s. per ton, and that, therefore, the upward movement has particularly affected distant contracts. The main stimulating factor this week has been the Mexican news, suggesting that the shipments of Mexican lead from Tampico will be interrupted over a period by action on the part of the insurgents to establish a blockade at that port. Current quotations:—*Soft foreign (prompt)*: Thursday, £32 5s.: Friday, £32; Monday, £32; Tuesday, £31 17s. 6d.: Wednesday, £32.

Dec. 31st, 1923.

BLAST FURNACES OF THE UNITED KINGDOM

BUILT AND IN BLAST.

Compiled from Returns Received Direct from the Furnaces, and Published at the Offices of

BESSEMER HOUSE, 5, DUKE STREET, ADELPHI, LONDON, W.C. 2
Telegrams—ZACATECAS, WESTRAND, LONDON. Telephone—GERRARD 6611 (2 Lines).

THE FOUNDRY TRADE JOURNAL, WITH WHICH IS INCORPORATED THE IRON & STEEL TRADES JOURNAL.

These Statistics have been published regularly each Quarter since 1879.

BESSEMER HOUSE, 5, DUKE STREET, ADELPHI, LONDON, W.C. 2
Telegrams—ZACATECAS, WESTRAND, LONDON. Telephone—GERRARD 6611 (2 Lines).

Total number of Furnaces Built on Dec. 31st, 1923	484
Total number of Furnaces in Blast on Dec. 31st, 1923	207
Decrease in the number of Furnaces Built	1
Increase in the number of Furnaces in Blast since Sept. 30th, 1923	18
Furnaces Blown-in since Sept. 30th, 1923	23

Scotland (1).—Jas. Dunlop & Co., Ltd., 1.
South Wales (2).—Briton Ferry Works, Ltd., 1; Blaenavon Co., Ltd., 1.
Durham and Northumberland (4).—Consett Iron Co., Ltd., 1; Seaton Carew Iron Co., Ltd., 1; Pease & Partners, Ltd., 2.
Lincolnshire (2).—North Lincolnshire Iron Co., Ltd., 2.
Cleveland (5).—Gjers, Mills & Co., Ltd., 1; Pease & Partners, Ltd., 2; W. Whitwell & Co., Ltd., 2.
West Cumberland (1).—Whitehaven Hematite Iron & Steel Co., Ltd., 1.
North Staffordshire (2).—R. Heath & Low Moor, Ltd., 1; Goldendale Iron Co., 1.
South and West Yorkshire (1).—Walter Scott, Ltd., 1.
Lancashire (2).—Charcoal Iron Co., 1; Partington Steel & Iron Co., Ltd., 1.
Derbyshire (1).—Denby Iron & Coal Co., 1.
Northamptonshire (1).—Islip Iron Co., Ltd., 1.
South Staffordshire and Worcestershire (1).—R. Hingley & Sons, Ltd., 1.

Furnaces Blown-out since Sept. 30th, 1923 5

Scotland (1).—Shotts Iron Co., Ltd., 1.
South Wales (1).—Guest, Keen & Nettlefolds, Ltd., 1.
Durham and Northumberland (1).—Dorman, Long & Co., Ltd., 1.
Cleveland (1).—Bolckow, Vaughan & Co., Ltd., 1.
West Cumberland (1).—United Steel Companies, Ltd., 1.

Furnaces being built at present time 10

(See below).

Furnaces being Re-lined at present time 69

Durham (6).—Consett Iron Co., Ltd., 3; Dorman, Long & Co., 1; Seaton Carew Iron Co., 2.
Nottingham and Leicestershire (1).—Stanton Ironworks Co., 1.
Cleveland (19).—Bolckow, Vaughan & Co., Ltd., 9; Cargo Fleet Iron Co., 1; Wm. Whitwell & Co., 1; Dorman, Long & Co., 3; Cochrane & Co., 2; Pease & Partners, 3.
South Staffordshire (5).—Alfred Hickman, 2; G. & R. Thomas, 1; M. & W. Grazebrook, 1; Earl of Dudley, 1.
Staffordshire, North (4).—Robert Heath & Low Moor, 2; Shelton Iron, Steel & Coal Co., 1; Stafford Coal & Iron Co., Ltd., 1.
Cumberland (3).—United Steel Companies (Workington), 3.
North Wales (1).—Darwen & Mostyn Iron Co., 1.
Derbyshire (5).—Sheepbridge Coal & Iron Co., Ltd., 1; Clay Cross Co., 1; Denby Iron & Coal Co., 1; Stanton Ironworks Co., 2.
Northamptonshire (1).—New Cransley Iron Co., 1.
Lancashire (5).—North Lonsdale Iron & Steel Co., Ltd., 2; Barrow Hematite Steel Co., 2; Darwen & Mostyn Iron Co., 1.
Scotland (8).—Carron Co., 1; Shotts Iron Co., 2; David Colville & Sons, 1; Coltness Iron Co., 1; Wm. Dixon, Ltd., 1; Jas. Dunlop & Co., Ltd., 1; Merry & Cunninghame, Ltd., 1.
South Wales (8).—Ebbw Vale Steel, Iron & Coal Co., Ltd., 2; Guest, Keen & Nettlefolds, Ltd., 4; Blaenavon Co., 1; Briton Ferry Works, Ltd., 1.
South and West Yorkshire (2).—Newton, Chambers & Co., 1; Walter Scott, Ltd., 1.
Shropshire (1).—Lilleshall Co., Ltd., 1.

Scotland.

Name of Firm.	Total in blast on Dec. 31st.	In blast Dec. 31 making: Hem.	Fgs. & F.G'y.	Basic.	Average in blast: Dec. qr.	Sept. qr.	Total built.	Fires relining
Langloan Iron and Chemical Co., Ltd., Coatbridge	—	—	—	—	—	—	5	—
Coltness Iron Co., Ltd., Coltness	4	2	2	—	4	4	9	1
Dixon, Wm., Ltd., Calder	—	—	—	—	—	—	7	—
Dixon, Wm., Ltd., Govan	2	2	—	—	2	2	6	1
Dunlop, Jas., & Co., Ltd., Tolcross	4	1	3	—	3	3	5	1
Glasgow Iron and Steel Co., Ltd., Wishaw	4	4	—	—	4	4½	6	—
Merry and Cuninghame, Ltd., Carnbroe	—	—	—	—	—	—	5	—
Shotts Iron Co., Ltd. ..	3	—	3	—	3½	4	5	2
Summerlee Iron Co., Ltd. Coatbridge	4	—	4	—	4	4	7	—
Baird, Wm., & Co., Ltd., Gartsherrie	7	2	3	2	7	6	12	—
Baird, Wm., & Co., Ltd., Muirkirk	—	—	—	—	—	—	3	—
Baird, Wm., & Co., Ltd., Eglinton	6	3	3	—	6	6	6	—
Baird, Wm., & Co., Ltd., Lugar							5	
Dalmellington Iron Co., Ltd., Dalmellington	—	—	—	—	—	—	5	—
Merry & Cuninghame, Ltd., Ardeer	3	—	3	—	3	3	5	1
David Colville & Sons, Ltd., Glengarnock	4	—	4	—	4	4	7	1

Cleveland District.

Name of Firm.	Total in blast on Dec. 31st.	In blast Dec. 31 making: Hem.	Fgs. & F.G'y.	Basic.	Average in blast: Dec. qr.	Sept. qr.	Total built.	Fires relining
Dorman, Long & Co., Ltd., North Eastern Steel Works	12	—	2	—	12	12	4	1
Gjers, Mills & Co., Ltd.	3	3	—	—	2½	2½	5	—
Cargo Fleet Iron Co., Ltd.	12	—	—	12	12	12	5	1
Tees Furnace Co., Ltd., Lackenby	—	—	—	—	—	—	3	—
Bolckow, Vaughan & Co., Ltd.—								
Clay Lane	—	—	—	—	—	—	4	—
Cleveland, South Bank	4	—	1	—	4	4	5	2
Cleveland Steel Works, Eston	—	—	—	—	½	1	5	1
Middlesbrough ..	—	—	—	—	—	—	2	1
South Bank	3	—	1	—	3	3	7	—
Grangestown ..	—	—	—	—	—	—	2	—
Lindthorpe - Dinsdale Smelting Co., Ltd. (Linthorpe Iron Works)	2	2	—	—	2	2	6	—
Dorman, Long & Co., Ltd., Newport Ironworks	3	1	2	—	3	3½	7	1
Pease & Partners, Ltd., Normanby Iron Works	2	2	—	—	—	1	3	1
Cochrane & Co., Ltd.	1	—	—	1	1	1	3	2
Dorman, Long & Co., Ltd. Redcar Ironworks	2	—	—	2	2	3	6	1
Pease & Partners, Ltd.	4	—	—	—	4	4	5	1

Northamptonshire.

Name of Firm.	Total in blast on Dec. 31st.	In blast Dec. 31 making: Hem.	Fgs. & F.G'y.	Basic.	Average in blast: Dec. quarter	Sept. quarter	Total built.	Fires relining
New Cransley Iron Co. ..	1	—	1	—	1	1	2	1
Executors of P. Phipps, Hunsbury Hill Iron Works	—	—	—	—	—	—	2	—
United Steel Companies, Ltd, Wellingboro'	1	—	1	—	1	1	4	—
Islip Iron Co., Ltd., Thrapston	3	—	3	—	2	2	4	—
Kettering Iron and Coal Co., Ltd., Kettering	2	—	2	—	2	2	3	—
Wellingboro' Iron Co., Ltd., Wellingboro'	1	—	1	—	1	1	3	—
Lloyd's Ironstone Co., Ltd.	2	—	—	2	2	2	3	—
Totals	10	—	8	2	9	9	21	1

South Staffordshire and Worcestershire.

Name of Firm.	Total in blast on Dec. 31st.	In blast Dec. 31 making: Hem.	Fgs. & F.G'y.	Basic.	Average in blast: Dec. quarter	Sept. quarter	Total built.	Fires relining
T. & I. Bradley, Ltd. (Cappondfield)	—	—	—	—	—	—	2	—
Bradley & Foster, Ltd., Darlaston	—	—	—	—	—	—	2	—
G. & R. Thomas, Hatherton	1	—	1	—	1	1	2	1
	—	—	1*	—	1	1	4	1

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Jno. STEVENSON, Ltd.
(Formerly JNO. STEVENSON),
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HARRIS & PEARSON,

Carron Co., Carron	3	—	3					
Totals	44	14	28	2	43½	43½	102	8

North Wales.

Brymbo Steel Co., Ltd.	1	—	—	1	1	1	1	—
Darwen & Mostyn Iron Co., Ltd., Mostyn	*2	—	—	—	2	2	3	1
Totals	3	—	—	1	3	3	4	1

*Two furnaces making ferro-manganese, etc.

South Wales & Mon.

Briton Ferry Works, Ltd. Briton Ferry	1	1	—	—	1	—	2	1
Baldwins, Ltd., Cwmavon Works, Glamorgan	—	—	—	—	—	—	2	—
Baldwins, Ltd., Swansea Hematite Works, Landore	—	—	—	—	—	—	2	—
Baldwins, Ltd., Margam	2	—	—	2	2	2	2	—
Crawshay Bros. (Cyfarthfa), Ltd.	—	—	—	—	—	—	5	—
Guest, Keen & Nettlefolds, Ltd., Dowlais	1	1	—	—	1½	2	4	2
Guest, Keen & Nettlefolds, Ltd., Cardiff	1	1	—	—	1½	1	4	2
Guest, Keen & Nettlefolds, Ltd. (Cwmbran, Mon.)	—	—	—	—	—	—	1	—
Blaenavon Co., Ltd., Blaenavon	2	2	—	—	2	1½	3	1
Ebbw Vale Steel, Iron and Coal Co., Ltd.	3	2	—	1	3	2½	9	2
Fyle & Blaina Works, Ltd.	—	—	—	—	—	—	2	—
Totals	10	7	—	3	11½	9	36	8

Durham and Northumberland.

Dorman, Long & Co., Ltd., Carlton Iron Works	*1	—	—	—	2	2	3	1
Dorman, Long & Co., Ltd., Clarence Works	2	—	—	2	2	2	11	—
Consett Iron Co., Ltd., Blackhill	4	4	—	—	3	3	8	3
Palmers Shipbuilding and Iron Co., Ltd., Jarrow	—	—	—	—	—	—	5	—
Linthorpe-Dinsdale Smelting Co., Ltd., Middleton	†3	—	—	—	3	3	4	—
Seaton Carew Iron Co., Ltd., West Hartlepool	2	1	—	1	1½	1½	4	2
Pease & Partners, Ltd., Tees-Bridge Iron Wks.	2	—	2	—	½	—	3	—
Weardale Steel, Coal and Coke Co., Ltd., Tudhoe Furnaces, Spennymoor	—	—	—	—	—	—	2	—
Totals	14	5	2	3	12½	11½	40	6

*One furnace making ferro-manganese, etc.
†Three furnaces ditto.

Lincolnshire.

Appleby Iron Co., Ltd., Frodingham	3	—	—	3	3	3	4	—
Frodingham Iron and Steel Co., Ltd., Doncaster	3	—	—	3	3	3	4	—
Redbourn Hill Iron and Coal Co., Ltd.	4	—	—	4	4	3	4	—
North Lincolnshire Iron Co., Ltd., Scunthorpe	2	—	—	2	—	1½	3	—
Trent Iron Co., Ltd., Scunthorpe	2	—	—	2	2	2	3	—
John Lysaght, Ltd., Normanby Park Steelworks, Scunthorpe	5	—	—	5	5	4½	5	—
Totals	19	—	—	19	17	17	23	—

Notts. and Leicestershire.

Beetwood Coal and Iron Co., Ltd., near Nottingham	2	—	2	—	2	2	4	—
Stanton Ironworks Co., Ltd., Ashoridby	3	—	3	—	3	3	4	1
Totals	5	—	5	—	5	5	8	1

Shropshire.

Madeley Wood Co. ..	—	—	—	—	—	—	3	—
Lilleshall Co., Ltd. ..	2	—	—	2	2	2	3	1
Totals	2	—	—	2	2	2	6	1
Totals . ..	32	12	16	4	28½	32½	73	19

NOTE:—Basic heading includes furnaces making Cleveland pig-iron for steel-making purposes.

West Cumberland.

United Steel Companies, Ltd., Harrington, Derwent Solway, Moss Bay, Workington	*5	4	—	—	6	7	18	3
United Steel Companies, Distington	—	—	—	—	—	—	3	—
Millom & Askam Hematite Iron Co., Ltd., Millom	1	1	—	—	1	1	5	—
Whitehaven Hematite Iron & Steel Co., Ltd.	1	1	—	—	1	—	3	—
Totals	7	6	—	—	8	8	29	3

* One furnace making ferro-manganese, etc.

North Staffordshire.

Midland Coal, Coke and Iron Co., Ltd., Apedale	2	—	1	1	2	2	5	—
R. Heath & Low Moor, Ltd., Stoke	1	—	1	—	½	½	5	2
Goldendale Iron Co. ..	1	—	1	—	1	½	2	—
Stafford Coal and Iron Co., Ltd.	3	—	3	—	3	3	4	1
Shelton Iron, Steel and Coal Co., Ltd., Stoke	2	—	—	2	2	2	4	1
Totals	9	—	6	3	8½	8	20	4

South and West Yorkshire.

Walter Scott, Ltd., Leeds Steelworks	2	—	1	1	1½	1	4	1
R. Heath & Low Moor, Ltd.	*1	—	1	—	1	1	2	—
Parkgate Iron and Steel Co., Ltd.	1	—	—	1	1	1½	3	—
Newton, Chambers & Co., Ltd., Sheffield	2	—	2	—	2	2	3	1
Yorks Iron and Coal Co., Ltd., Leeds	2	—	2	—	2	2	4	—
Wm. Woodhead & Son, Ltd., Bradford	—	—	—	—	—	—	1	—
Totals	8	—	6	2	7½	7½	17	2

*Cold Blast.

Lancashire.

Millom & Askam Co., Ltd., Askam	—	—	—	—	—	—	1	—
Charcoal Iron Co., Ulverston (Backbarrow)	1	1	—	—	1	—	1	—
Barrow Hematite Steel Co., Ltd.	2	2	—	—	2	2	8	2
Carnforth Hematite Iron Co., Ltd., Carnforth	1	1	—	—	1	1	3	—
Darwen & Mostyn Iron Co., Ltd., Darwen	*1	—	—	—	2	2	2	1
Wigan Coal and Iron Co., Ltd.	†2	—	—	1	2	2	5	—
North Lonsdale Iron and Steel Co., Ltd.	2	2	—	—	2	1½	4	2
Partington Steel & Iron Co., Ltd., Irlam, near Manchester	3	—	—	3	2½	2½	6	—
Totals	12	6	—	4	12½	11	30	5

* One furnace making ferro-manganese, etc.
† Ditto " " " "

Derbyshire.

Stanton Ironworks Co., Alfreton	2	—	2	—	2	2	3	1
Butterley Co., Ltd., Alfreton (Butterley Wks.)	—	—	—	—	—	—	2	—
Clay Cross Co. ..	1	—	1	—	1	1	3	1
Denby Iron and Coal Co.	2	—	2	—	1½	1½	4	1
E. P. Davis, Bennerley ..	2	—	2	—	2	2	3	—
Ditto, Erewash ..	—	—	—	—	—	—	2	—
Renishaw Iron Co., Ltd., Chesterfield	1	—	1	—	1	1	1	—
Sheepbridge Coal and Iron Co., Ltd.	2	—	2	—	2	2	4	1
Staveley Coal and Iron Co., Ltd., Staveley and Devonshire Works	6	—	6	—	6	6	12	—
Stanton Ironworks Co.	8	—	8	—	8	8	9	1
Totals	24	—	24	—	23½	23½	43	5
Totals . ..	1	—	1	—	1	—	2	—
Alfred Hickman, Ltd. ..	3	—	3	3	3½	5	2	
Willingsworth Iron Co., Ltd., Wednesbury	—	—	—	—	—	—	—	
M. & W. Grazebrook, Ltd., Dudley	1	—	1	—	1	1	2	1
Cochrane & Co., Dudley	—	—	—	—	—	—	2	—
Baldwins, Ltd. (Netherton Furnaces)	1	—	—	1	1	1	2	—
Wm. Roberts (Tipton), Ltd.	—	—	—	—	—	—	3	—
The Birchill's Furnaces, Ltd., Walsall	—	—	—	—	—	—	2	—
Totals	8	—	4	4	8	7½	30	5

*Cold Blast.

Gloucester, Somerset, and Wilts.

New Westbury Iron Co., Ltd.	—	—	—	—	—	—	2	—
Totals	—	—	—	—	—	—	2	—
GRAND TOTALS FOR UNITED KINGDOM .	207	50	99	49	199½	198	484	69

New Furnaces Building (10).

DERBYSHIRE (3):—Stanton Ironworks Co., 2; Renshaw Iron Co. Ltd., 1.
SOUTH STAFFS (2):—Bradley & Foster, Ltd., 1; T. & I. Bradley, 1.
SOUTH WALES (1):—Baldwins, Ltd., 1.
LINCOLNSHIRE (2):—Appleby Iron Co., 2.
NOTTS AND LEICESTERSHIRE (1):—Stanton Ironworks Co., Ltd., 1.
CUMBERLAND (1):—Millom & Askam Hematite Iron Co., 1.

Number of Furnaces in Blast on Dec. 31, 1923.

District.	Average in blast for Quarter.	Total in blast on Dec. 31, 1923	Total in blast on Dec. 31 making Hem.	Spgs. & F'dy.	Basic.	Ferro-Man., etc.
Scotland	43¼	44	14	28	2	—
Durham and Northumberland ..	12½	14	5	2	3	4
Cleveland	28½	32	12	16	4	—
Northamptonshire	9	10	—	8	2	—
Lincolnshire	17	19	—	—	19	—
Derbyshire	23½	24	—	24	—	—
Notts and Leicestershire ..	5	5	—	5	—	—
S. Staffordshire & Worcestershire ..	8	8	—	4	4	—
North Staffordshire	8½	9	—	6	3	—
West Cumberland	8	7	6	—	—	1
Lancashire	12½	12	6	—	4	2
South Wales & Mon.	11½	10	7	—	3	—
South and West Yorkshire ..	7½	8	—	6	2	—
Shropshire	2	2	—	—	1	1
North Wales	3	3	—	—	1	2
Gloucester, Somerset, and Wilts. ..	—	—	—	—	—	—
Totals	199½	207	50	99	49	9
Totals for Previous Quarter ..	198	189	38	98	42	11

Average Number of Furnaces in Blast for the previous Six Quarters.

District.	Sept. 1923.	June, 1923.	Mar. 1923.	Dec. 1922.	Sept. 1922.	June, 1922.
Scotland	43¼	46½	39½	32	18½	12½
Durham and Northumberland	11½	14	11½	8½	8	8½
Cleveland	32½	34	32½	24½	21	18½
Northamptonshire ..	9	9½	10	9½	9	6½
Lincolnshire	17	18	14	11	9½	9
Derbyshire	23½	24	19½	17	14½	12
Notts and Leicestershire	5	5	4½	3	3	2
S. Staffordshire and Worcestershire	7½	10	7	6½	6½	6
North Staffordshire ..	8	11	10	9	6	5
West Cumberland ..	8	11½	11	9½	7½	7
Lancashire	11	14	12	10½	7	7½
South Wales & Mon. ..	9	10½	8	7	9½	9½
South and West Yorkshire	7½	8½	8	7	7	6
Shropshire	2	2	1½	1	1	½
North Wales	3	3	3	2	2	—
Gloucester, Somerset and Wilts.	—	—	—	—	—	—
Totals	198	222	191½	157½	130	112½

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